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[OFFICIAL NOTICE.]

Thirty-Second Annual Meeting, New England Association of Gas Engineers.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS,
OFFICE OF THE SECRETARY,
NEW BEDFORD, MASS., Dec. 26th, 1901.

The Thirty-Second Annual Meeting of the New England Association of Gas Engineers will be held in Boston, February 19 and 20, 1902. The headquarters will be in Youngs' Hotel as usual; but, owing to the increased attendance at the meetings, which necessitates the securing of a larger assembly room, the sessions will be held in the Parker House.

A lively interest in the meeting is being shown by members, and the programme in detail will be issued later. W. W. GIFFORD, Sec'y.

[OFFICIAL NOTICE.]

First Annual Meeting, Wisconsin Gas Association.

RACINE, WIS., Jan. 15th, 1902.

The First Annual Meeting of the Wisconsin Gas Association will be held in Madison, Wis., on Wednesday and Thursday, the 12th and 13th days of February. The headquarters of the Association will be at "The Park," where accommodations can be had at the rate of $3 per day, and rooms with baths for $4 per day.

Unless advised to the contrary the Association meetings will be held in "The Park." HENRY H. HYDE, Secretary,
Wisconsin Gas Association.

[OFFICIAL NOTICE.]

Ohio Gas Light Association—Novelty Advertising Department.

OHIO GAS LIGHT ASSOCIATION,
OFFICE OF THE SECRETARY,
DELAWARE, O., Dec. 24, 1901.

Members of the Ohio Gas Light Association are earnestly requested to send to Mr. B. W. Perkins, South Bend, Ind., any contribution they may have for the Novelty Advertising Department of the Association. This is a most favorable time, just at the close of the season, when the many successful methods of advertising tried during the year are still fresh in the minds of those who used them. T. C. JONES, Sec'y.

BRIEFLY TOLD.

THE EDISON COMPANY MUST SHARE THE BURDEN.—After much contesting, in the courts and out of them, it has been at last determined that the Edison Electric Illuminating Company, of Boston, will share with the Boston Gas Light Company the burden of the damages done to persons and property through the disastrous explosion that occurred in the Boston subway, at Tremont and Boylston streets, that city, March 4, 1901. A correspondent forwards the following respecting the case as

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it stands at present: "It was learned yesterday (Jan. 17th) that the Edison Company concedes its liability, and will contribute its quota to the compensation awarded the sufferers. The claims amount to something less than $1,500,000, and the greater part of them have already been settled. It is understood that the Edison Company's payments in the settlements will be in the ratio of one-third."

OBITUARY NOTE—MRS. W. H. WHITE.—The fraternity will mourn with Captain William Henry White over the affliction that has beset him in the death of his estimable wife, whose demise occurred last Tuesday. The ending was the sad sequel to an illness of many years' duration, the sufferings of which were borne with the fortitude of the gentlewoman that she was. The funeral services were held at the city residence, the afternoon of last Thursday, and interment was made in Greenwood Cemetery the following day.

NOTES.—The properties of the Menominee (Mich.) Gas Company have been purchased by the Menominee Electric Light and Street Railway Company. The sale or change was made by Mr. J. M. Crawford.——Messrs. Adam Weber Sons, of New York, have been awarded a contract for the construction of 16 benches of 9's and 8 benches of 6's in the works of the Detroit (Mich.) Gas Company.——City Attorney Stone, of Louisville, Ky., has completed the draft of a bill which is to be put before the Kentucky State Legislature. Its purpose is to enable the city of Louisville to sell the $925,000 par value of stock that it holds in the Louisville Gas Company. The text of the measure is as follows: Be it enacted by the General Assembly of the Commonwealth of Kentucky:

Section 1. That wherever any city of the first class shall own any stock in a gas company carrying on business within its boundaries, the said city shall have the right to sell and dispose of the same upon such terms as may be prescribed by ordinance duly passed by the General Council of the said city and approved by its Mayor, in the manner that other ordinances are so passed and approved, but said stock shall not be sold for less than par.

Sec. 2. The proceeds of the sale of any such stock shall be applied, so far as they will suffice for that purpose, to the construction of public sewers, and held and used solely for that purpose, but the purchaser or purchasers of such stock shall not be required to look to the application of the purchase money.

Sec. 3. The General Council may, on such terms and conditions as shall be prescribed by ordinance passed as aforesaid, authorize the Mayor of said city to consent, on behalf of the General Council, to such amendments to the charter of any such gas company as may be approved by the board of directors of any such gas company, and so as to vest in the said board of directors and stockholders of said company the same power and authority to deal with its charter as the stockholders and directors of any other corporation organized under the law of the State of Kentucky would have.

Sec. 4. As it is necessary that the funds shall be provided for the construction of public sewers at as early a date as possible, an emergency is hereby declared to exist, and this act shall take effect upon its approval by the Governor.

"The Directors of the Louisville (Ky.) Gas Company have formally appointed Mr. F. A. Nobbe, Secretary to the Company, which position has been held for the past 16 years by Mr. E. S. Porter, who is now in New Mexico to recover his health. He is still in the employ of the Company, and President Snead declares that as soon as his health is sufficiently improved to permit him to return to the city he will again become Secretary of the Company. Letters from Mr. Porter say that since his arrival in New Mexico his health has improved materially. President Snead said yesterday that the Company had always regarded Mr. Porter as one of its most efficient and faithful employees. Mr. F. A. Nobbe, who has been appointed as Secretary, has been with the Company for the past 30 years. During the past 10 years he has served as Chief Clerk.—T. F. G."——At the annual meeting of the shareholders in the Consolidated Gas and Electric Light Company, of Batavia, N.Y., the following Directors were chosen: John H. Ward, Myron H. Peck, E. O. McNair, S. D. Purdy and C. J. Purdy.——The proprietors of the Marquette (Mich.) Gas Company have notified the residents that after February 1st the selling rate on illuminating account will be put at $1.60 per 1,000 cubic feet gross, less 10 per cent. for prompt payment. The gross rate on a fuel supply is to be $1.35 per 1,000, with 10 per cent. off for prompt payment.——Ontario (Can.) capitalists are interested in a projected gas plant for Oak Harbor, Can.——The mains of the Pottstown (Pa.) Gas Company are to be extended through the suburb known as Van Buskirk's Addition.

[Concluded from Page 80.]

Combustion in Gas Producers and Benches.

[Prepared for the JOURNAL, by MR. ROBERT W. PROSSER.]

Suppression of Temperature by Increased Specific Heat.—Formerly it was stated by all authorities that the specific heat of gases was the same at all temperatures, and the experiments of Regnault apparently proved this (except in the case of CO_2) up to temperatures of 400°; but it is now the general opinion that the specific heat of all gases does increase at high temperatures, but in what ratio is unknown.

Mallard and Le Chatelier advanced a theory, to explain the suppression of temperature in gas engines, that the specific heat of nitrogen, oxygen and CO_2 was doubled at 3,600°. This figure appears to have been simply a surmise, to account for a phenomenon which seemed to be otherwise inexplicable.

The suppression of temperature in compound gases by increased specific heat is so intimately connected with its suppression by dissociation, that it is extremely difficult to separate them, and this probably accounts for the meager information we have on these subjects.

Dissociation.—The investigation of this phenomenon has absorbed the attention of many eminent men, among whom may be mentioned, Deville, Bunsen and Grove, but beyond proving the existence of dissociation, the published data on the subject are very limited.

The first named (who may be almost claimed as an American, as he was born in the West Indies), probably gave the most exhaustive study to this subject, but as his writings are all in French, and I believe have never been translated as a whole, his results are not so accessible as those of English writers.

Deville applied the term "dissociation" to the decomposition by heat of compounds which recombined on reduction of temperature, and this is a concise definition of its present meaning.

He showed that steam began to decompose into O and H by heat alone, at a temperature of about 1,800°; and proceeded slowly at higher temperatures, there being no one temperature at which the entire volume was decomposed. The experiments were, I believe, made at constant volume, and did not go above 2,200°.

He also succeeded in partially decomposing CO_2 and CO, and actually condensed the carbon gas into solid carbon while in a state of dissociation.

The difficulty of investigations in this field will be appreciated when it is realized that all measurements and weights must be determined at temperatures of 2,000° or 3,000°, or more, and that the mass under examination, must necessarily be very small.

Whether the suppression of heat at high temperatures is due to dissociation, or increased specific heat, or both, it is probable that at some point above those temperatures which have been observed, the changes occur very rapidly, as most curves representing graphically mathematical, chemical or physical changes, which start with an approximately horizontal line (as is the case with those representing specific heats and dissociation at observed temperatures) end with a line approximately vertical.

If complete dissociation and greatly increased specific heat do occur in this manner at high temperatures, a slight lowering of the temperature, by liberating the heat absorbed, would explain the excessive localization of intense heat with ordinary combustion, and the only way by which this can be avoided is by primary and secondary combustion (with some loss of sensible heat), as in the ordinary producer. On every other assumption, dissociation and increased specific heat should reduce localization and prolong and distribute the intensity of combustion, as in the gas engine.

Deville's theory of dissociation was that it proceeded slowly with increased temperature, as in the formation of steam at a constant volume in the presence of water.

His experiments proved his theory; but there seems nothing in the way of carrying the analogy still further, and concluding that at some fixed temperature, *under constant pressure*, complete dissociation will take place, if the heat is applied long enough, in the same way that water is completely evaporated at atmospheric pressure by a temperature of 212°, if applied for a sufficient length of time.

Intimately connected with dissociation must be the phenomenon observed by Davy, that a reduction of pressure to 1-18th of that of the atmosphere prevented explosions of combining volumes of O and H.

Reduction of density by heat may possibly account for dissociation, but if the pressure given by Davy is the limit at which explosions can occur, the temperature required to rarefy steam to this point would be 8,300°.

Dissociation of CO_2 is effected at lower temperatures than is required for steam (Clerk).

As there is no actual loss of heat by its suppression by dssociation and increased specific heat, they are only of interest in considering improper combustion in the producer, as the required temperature in the bench is not high enough to be materially affected by these causes.

Steam Passing the Producer without Decomposition.—The reduction of temperature from this cause is about 25 per cent. more than would be occasioned by the same volume of nitrogen, for the reason that, although the nitrogen has 50 per cent. greater weight than the steam, its specific heat is only about half that of steam.

As previously stated, the Mond producer takes about three times as much steam as it decomposes, and the ordinary water gas generator takes from 50 per cent. to 100 per cent. more than is theoretically required.

Mr. Alten S. Miller gives the quantity of water (or steam) as 29.5 pounds per 1,000 cubic feet of gas made at the East River gas works in the Lowe generator. Of this gas, probably 700 cubic feet was water gas derived from the coal in the generator, and 300 cubic feet from the oil.

This would make the quantity required per 1,000 cubic feet of water gas equal to 42 pounds, including that used for purging. The quantity of steam theoretically required per 1,000 cubic feet is 23.8 pounds.

Generators fed by steam under pressure would naturally be more likely to pass steam undecomposed than if fed at atmospheric pressure, but there is no doubt that a considerable quantity does pass under this latter condition, as it is shown by condensation from Siemens' generators; and Dr. Bunte's experiments seem to show that it is extremely difficult to get a complete decomposition of steam by hot carbon, even in a laboratory experiment.

Where the analysis of producer gas is made over water, this steam will not appear, and no analysis will show dissociation, as the gases recombine on reduction of temperature.

The gas from the producer using 50 per cent. of steam probably represents an average composition of producer gases, after correcting for CO_2, which is always present in greater or less volume.

The composition given, if reduced to percentage volumes, will be:

Hydrogen	12.89
Carbonic oxide	38.66
Nitrogen	48.45
	100.00

The effect on the volume of gas, if part of the CO is turned into CO_2, will be that the combined volumes of CO and CO_2 will be the same as the original volume of CO, but the nitrogen will be increased by 1.881 volumes for every volume of CO_2 formed from CO.

Take, for example, the above gas, but containing 7 per cent. of CO_2, the volume will be increased 15.16 per cent, and the composition will be as follows:

	New Volume.	Per Cent. Volume.
Hydrogen	12.89	11.19
Carbonic oxide (38.66 − 8.06)	30.60	26.57
Carbonic acid	8.06	7.00
Nitrogen 48.45 + (1.881 × 8.06)	63.61	55.24
	115.16	100.00

To find 8.06, let P = per cent. (or, in this case, 7)—

$$\frac{100\ P}{100 - 1.881\ P} = 8.06$$

The production of CO_2 in a producer, exclusive of the loss by radiation and the destruction of the material of the producer, should not be a source of any theoretical loss, as the heat is all carried to the bench, but practically, as before stated, the results are not satisfactory even with an internal generator, the radiation from which must be very small.

The preheating of the primary air necessitates a further supply of steam to keep down the temperature of the fire, but there is always a loss in using steam, from the increased volume added to the waste gases, and the greater specific heat of steam, which is about twice that of the average waste gases.

This preheating appears to be a source of loss rather than gain, as the heat of the producer, from internal combustion to CO, is already too great for practical working, and it has to be cooled by steam, involving some loss in final results.

Whether this be so or not, the perfunctory manner in which the primary air is now heated to perhaps 200° or 300°, is not sufficient to show any material loss or gain.

In analyses of water gas from water gas generators very frequently the O present, both free and in combination, will not account for the large volume of H, assuming them both to have been derived from the steam. The only other source is the coal (anthracite) which usually contains 3 or 4 per cent. by weight of H, or about 12,000 to 16,000 cubic feet per ton, if H were free. Part is, however, in combination with O, and the volume is greatly reduced.

In producers run with anthracite coal it is not, therefore, safe to assume that the H present has all been derived from the steam.

If the free H is in considerable volume, it might possibly pay to save it by heating the coal in the generator to expel the H previous to blasting and decomposing by steam.

The waste heat from a bench escaping at more than 2,000°, would represent an enormous loss, but after recuperation and losses by radiation, the temperature is so much reduced that all attempts to conserve this heat have hitherto met with only partial success.

The heat theoretically required to carbonize an average gas coal is difficult to arrive at, but by the most liberal estimate it cannot amount to more than 800 B. T. U. per pound of coal; of which the greater part is due to loss of sensible heat, and not of the latent heat, as I believe is generally supposed. The heat actually used (3,000,000 B. T. U. per ton) is equal to 1,340 B. T. U. per pound of coal, showing a loss of perhaps 40 per cent.

In a bench of nines, carbonizing 9 tons of coal per day, this loss would amount to 10,800,000 B. T. U., or allowing 50 per cent. for radiation and losses, say 5,400,000 B. T. U., equal to about 400 pounds of coke or from 4 to 5-horse power per hour. This would hardly pay to recover, and though the waste from a poor design of bench would be much greater, it would be better to give more attention to improving the bench than to attempt to utilize the products of its wasteful operation.

In stating that this heat is hardly worth conserving, I am taking into account the mechanical difficulties and expense of applying a steam boiler to a retort bench, and also that the average use of the bench is only about 220 days per year.

I believe that some experiments have been tried to arrive at the quantity of heat theoretically required to carbonize coal, but I do not know the results.

The heat saved by using hot coke in the producer, at a temperature of 2,000°, assuming the specific heat of coke to be .203, would be 406 B. T. U. per pound of coke burnt, but by some rather crude experiments at a less temperature, the heat in the coke was found to be nearly 600 B. T. U., thus apparently showing that the specific heat is greatly increased at high temperatures.

Direct experiments in running producers with hot and with cold coke show a still greater economy, amounting to nearly 10 per cent. of the whole heat value of the coke.

If there were any practicable temperature at which steam could be entirely decomposed by dissociation, it would be possible to furnish a fire with steam alone for the support of combustion (or rather the oxidation of carbon) without admitting any air. Some inventors of water gas apparatus have claimed this as a possibility, but it has never been done.

If the specific heat of steam remains constant at all temperatures, and there is no dissociation, it would have to be raised 1,922° in temperature to just furnish the heat for its own decomposition with carbon to CO_2 and H.

For the combustion (?) of 1 pound of carbon, 3 pounds of steam would be required, and the resulting gases would be, ⅛ pound H and 3⅜ pounds of CO_2.

The heat of this combustion would be distributed as follows:

Heat of decomposition of 3 pounds steam at 5,756 =	17,268 B. T. U.
Heat of combustion of 1 pound carbon to CO_2	14,500 B. T. U.
Sensible heat of steam 3 pounds at .48 × 1,922°	2,768 "
	17,268 "

The ⅛ pound of H set free would by its combustion to steam produce 17,268 B. T. U., of which 2,768 B. T. U. had been imparted to the steam before its decomposition.

This ⅛ pound of H requires the same amount of air for its combustion as the 1 pound of carbon would have done if burnt direct in air.

The total weight of the waste gases per pound of carbon burnt would be 15.478 pounds, and specific heat .283.

The volume of gases before final combustion would be 94.68 feet, and heat units of combustion to steam, 182 per cubic foot.

For primary combustion, or the production of CO and H from the producer, there would be required 1⅛ pounds of steam, and the resulting gases would be ⅛ pound H and 2⅛ pounds CO, with a volume of 63.12 cubic feet, and heat value of 325 B. T. U. per cubic foot on combustion

to CO_2 and steam. The final combustion will require the same quantity of air as the 1 pound of carbon would have required originally.

The weight of waste gases will be 13.978 pounds and the specific heat .262.

In this case the steam would have to be raised 6,033° to furnish the heat for its own decomposition in the presence of carbon.

From our experience with water gas generators it is necessary to have a temperature of upwards of 2,000° in the fire, to attain the best results by producing the most CO with the least CO_2. There is no loss of heat by this temperature which may be saved by recuperation except that due to radiation, but it appears to be necessary for effective decomposition.

The heat of the steam would not be sufficient to maintain this temperature, as it requires all the heat it contains to effect its own decomposition. Consequently the steam would also have to be raised at least 2,000°, making the temperatures in the two cases about 4,000° and 8,000° respectively.

Both of these temperatures are impracticable, but there is no doubt that the temperature of the steam to effect these decompositions would be much less than that given, owing to its increased specific heat and dissociation. The reduction would probably not be sufficient to make either of these combustions of any practical value, and the other disadvantages of increased weight and specific heat of waste gases, and the superheating of steam from outside sources, seem to far outweigh any possible advantages.

As all furnaces and fires are more or less affected by atmospheric conditions, a retort bench is no exception, and it has certain days when its efficiency is not so great as on others. This loss of efficiency appears to be not altogether due to either the wind, temperature, pressure or hygrometric state of the atmosphere, though the wind is doubtless the most potent factor.

To avoid this cause of uneven working, the running of benches by means of a forced draft has been suggested and has many points to recommend it. This idea has doubtless suggested itself to many; but, so far as I know, it was first put forward by Mr. G. E. Stevenson, in 1884.

The pressure required for this purpose would not exceed one-half an inch of water, and the total volume of air required for a producer using 1 ton of carbon in 24 hours would be 336,000 cubic feet, equal to 873,600 foot pounds, or $\frac{1}{50}$th of a horse power per hour. This is the theoretical power required, and though the actual power might exceed this 5 or 6 times, the cost of furnishing the air would be very slight, and would not exceed 10 cents per day per bench for power in a large works.

The advantages of this system would be that:

1. The bench being under a slight pressure in all parts, there would be no chance of leakage of ouside air into the bench.

2. The primary and secondary slides being set, there would be a certainty that the quantity of air passing through them would be always the same.

3. An increase of pressure in the ash pit, from accumulation of ashes and clinker in the fire, would show that the fire was not getting its proper supply of air.

4. The expense of the chimney flues and chimneys would be saved, and their places taken by one underground flue and no chimney or a dwarf one to carry the hot gases to a convenient height.

5. The secondary flues could be made more effective for heating by being made narrower, as the increased friction would be no objection with a forced draft.

6. No dust would be carried into the primary or secondary flues with the air, but this is not a source of much trouble with existing arrangements.

The pressure on the underside of the arch due to the levity of the hot gases at 2,000° for a column say 10 feet high above the fire would be $\frac{1}{4}$th inch of water.

The temperatures of combustion as given by different authorities show great variations, partly for the reason that the conditions under which the experiments or calculations were made are not clearly stated.

The calculated temperatures of combustion of carbon and hydrogen, in just sufficient air to complete the combustion at atmospheric pressure are given as about:

Carbon	4,900°.
Hydrogen	4,800°.

Calculated according to the equivalents before mentioned (using 51,804 B. T. U. per pound of hydrogen burnt to steam) from 60° normal temperature, these results will be:

Carbon	4,990°.
Hydrogen	4,871°.

This does not take into account the moisture in the atmosphere at 60° temperature, which if saturated will be per pound of combustible $\frac{1}{76}$ pound in the hydrogen and $\frac{1}{8}$ pound in the carbon combustion. This deduction will be very small and particularly as the atmosphere is seldom in a saturated condition.

The temperature of combustion of carbonic oxide and hydrogen from the producer using 50 per cent. steam, and assuming the producer gases and secondary air to have a temperature of 1,000° before combustion, will be 5,160° F., but it is needless to say that no such temperature is ever attained in a bench of retorts.

As previously stated, these calculations are made on the assumptions that the specific heat is constant at all temperatures and that there is no dissociation, but these assumptions are not confirmed by recent experience, and such calculations are of little practical value at high temperatures; but below 2,000° they are approximately correct.

The observed temperatures of the combustion of H in the atmosphere vary from 3,300 to 3,750, and the calculated temperature is in some cases as high as 6,000°.

Other observed, calculated, and estimated temperatures are as follows:

The temperature in a blast furnace is supposed to be about 4,500°, but experiments made in Germany showed only a maximum of 2,600°, or about the melting point of cast iron. It is difficult to imagine that it can be much in excess of this, as it would be absorbed by a further reduction of metallic iron and decomposition of limestone, but immediately opposite the tuyeres, and before it has time to diffuse, it may greatly exceed the German figures.

The theoretical temperature of the blast furnace with air heated 900° is about 5,700°. Deville's experiments with the oxyhydrogen flame gave results somewhat less than 4,500°. Bunsen estimated this flame at 5,000°.

The melting point of platinum is estimated at 3,100° to 3,300°, and it is easily melted by the oxyhydrogen flame. Deville melted a thin filament of platinum in the flame of an ordinary candle. The melting point of cast iron is variously stated at from 2,000° to 2,600°.

It is not probable that the temperature of the retorts in a bench ever exceeds 2,000°, though it may be greatly in excess of this at the nostrils where the secondary combustion takes place.

Independent experiments made by Mr. M. S. Greenough[1], and Col. F. S. Benson,[2] in 1877, showed maximum temperatures in the retorts of 2,179° and 2,294°.

These determinations were made by heating iron in the retorts and cooling it in water, and calculating the temperature from the rise of temperature of the water. If proper precautions are taken to prevent radiation, this method should give accurate results, *if the specific heat of the iron were known.*

The specific heat of the iron (probably cast) was assumed to be .126, and that it was constant at all temperatures; but as it is known that the specific heat of all solids increases with the temperature, there is an indefinable source of error in these experiments, as the specific heat near 2,300° is not known; but as it does increase in some ratio, the temperatures obtained by this method are necessarily too high. Some English estimates give this temperature as about 1,082° C. (1,980° F.).

The temperature of the secondary air at the point of combustion is from 1,000 to 1,200°. Attempts have been made to show that the temperature is not so high as this, and that anything put in the flue to measure the temperature is affected by the radiant heat of the material of the flue and not by the air. This might be a good argument if we did not know approximately the surface necessary to heat air to 1,000°; but this is shown by the operation of the hot blast stove for blast furnaces, the temperature of the air from which heats the outlet pipe to a dull red, which is the color assumed by all solids when heated to about 1,000°.

A temperature of 900° to 1,000 is used in the retorts for distilling shale in the manufacture of coal oil and paraffine, producing 2,000 or 3,000 cubic feet of gas, and 35 to 40 gallons of oil per ton. The gas is used for fuel, and the carbonization is apparently effected with less than 2,000,000 B. T. U. per ton.

The temperature in gas engine cylinders, at the instant of explosion calculated from the pressure produced, is frequently 3,000° (Clerk).

As might be inferred from Davy's experiments, on explosions at slight pressures the temperature of explosion is increased by pressure, and in proportion to it (Clerk).

The intensity of combustion in a blowpipe flame has been ascribed,

1. "Temperature of Retorts," American Gas Light Journal, March 16, 1877, p. 102.
2. "Temperature of Retorts at Different Periods of Charge," American Gas Light Journal, Dec. 3, 1877. p. 227.

and is no doubt due, to the rapidity of combustion, but this is apparently not due to the pressure on the blowpipe, as combustion does not appear to be retarded by a reduction in pressure, which would be a natural corollary.

This was shown by an experiment of Dr. Frankland, in which he found that a candle burnt in the rarefied atmosphere on top of the Alps consumed as much as it did near sea level, though in the former case the size of flame and illumination were much reduced.

In all these cases the amount of heat produced per pound of combustible must, of course, have been the same.

The capacity of the flues in a bench to deliver a certain *weight* of air or gas is reduced by increase of temperature in proportion to the square roots of the densities, at the given temperatures; and the relative capacity of a flue, at a uniform pressure and varying temperature, is as follows:

60° temp.	1.00 density.	1,000 pounds capacity.
580° "	.50 "	707 "
1,100° "	.33 "	577 "
1,620° "	.25 "	500 "
2,140° "	.20 "	427 "

The quantity of air required per second in the prodncer using 50 per cent. steam, and burning 1 ton of carbon (say, 2,450 pounds coke) per day is, for the primary flues, 1.3 cubic feet, and for the secondary flues, 2.6 cubic feet; but there is not generally this difference required in the openings of the primary and secondary slides, because the draft is greater in the secondary flues, and the production of CO_2 in the producer takes a greater supply of air through the primary slides. In some cases, however, the primary slide requires less than half the opening of the secondary, from leakage of air into the producer.

The volume of the waste gas is 4⅛ cubic feet per second, and its velocity at 2,000°, through the flues as ordinarily constructed, is about 5 feet per second.

As the amount of heat returned to the bench by recuperation is so small it would appear that this should be increased so that the secondary air enters the bench at very nearly the temperature of the waste gases on leaving it, or with much less difference than now apparently exists.

The conditions for effective recuperation are more favorable in a bench than in almost any other form of furnace, and though the cost of extra recuperation is high it may be shown that, if effective, it is a good investment, with any reasonable price for coke.

The first part of the recuperation, up to say 500° or 600°, could probably be effected with cast iron pipes more cheaply than with firebrick. By the old, cast iron, hot blast stoves formerly used, 1 square foot of surface heated about 1½ cubic feet of free air per minute to a much higher temperature, but more surface might be required in a bench for this purpose, as the temperature in this part of the waste flues would be less than that in the stove.

With coke at 5 cents a bushel the cost of fuel, by the best results as previously given, amounts to less than 3 cents per 1,000 feet of gas, but with the present abnormally high price of coke in New York the cost is twice this amount.

It is not possible to save more than ⅓ of the present cost of fuel (if so much), and this must be borne in mind in adding to the present cost of recuperation.

The economy of benches containing a great number of retorts was demonstrated shortly after the introduction of clay retorts, when it became the practice to use 10 or 12 iron and clay retorts in the same bench.

It is stated that some of these benches ran with a consumption of only 18 per cent. of the coke made, and there is no reason to doubt that an increase in the number and size of the retorts in a bench tends to increased economy of fuel.

The capacity of a bench cannot, however, be increased indefinitely, and the present production of 130,000 to 150,000 cubic feet per day in inclined benches is as large a unit as can be conveniently used, except in the largest works.

With coke selling in New York at over $6 per ton, which is its present price delivered, many fuels can successfully compete for firing benches, and among these is Texas crude oil, at any price below 2½ cents per gallon.

By various experiments the quantity of gas made in retorts during the first hour of carbonization varies from 27 per cent. to 78 per cent. of the total gas in the coal—an average of 11 tests with different coal being 53 per cent.

This shows great variation in the heat required during the time of carbonization, but in the retort coke oven the heat required, as shown by the quantity of gas produced, according to Dr. Schniewind, varies only from 3 per cent. to 4 per cent. per hour for the first 25 hours of carbonization, out of a total of 34 hours—the maximum being in the first hour—but is almost equaled in the 23d.

Carburetted Water Gas in Europe.

[Prepared for the JOURNAL, by J. T. WESTCOTT, M.E., C.E., Ph.D.]

Carburetted water gas, assisted by the Welsbach mantle, is the greatest heritage that the gas industry has at the present time. The first carburetted water gas plant was erected in the United States, at Phœnixville, Pa., in 1873, and the development has been so rapid that at the present time there are sufficient plants in operation in America to supply all the illuminating gas that is made and sold during the course of the year. Primarily, and unquestionably, Professor T. S. C. Lowe is the inventor of the modern process, and, outside of natural conditions, which have had much to do with its development, its gradual evolution to perfection is due to Messrs. A. O. Granger, J. H. Collins, Jr., and other independent operators, at the beginning; later on, to the untiring efforts of the corps of able engineers of the United Gas Improvement Company. Independent operators were driven from the field in 1889, at the time that the courts made a legal decision that the original patents of Professor Lowe were valid. This gave the United Gas Improvement Company, of Philadelphia, sole charge of this class of the business until the expiration of the Lowe patents in 1892. At this time several other companies came into the field, among them Messrs. Humphreys & Glasgow, the Western Gas Construction Company, and the Economical Gas Apparatus Construction Company, operating the Merrifield-Westcott-Pearson patents, the two former companies building practically the same type of plants as the United Gas Improvement Company.

During this period different Americans had thought of trying to introduce carburetted water gas into Europe, among them being Mr. B. Van Steenbergh, who had an experimental plant in operation at Knightsbridge, London, in 1890; also, Mr. T. G. Springer, who fixed a plant at one of the stations of the South Metropolitan Gas Company, South London. About 1889 a company was projected in England, with Mr G. C. Trewby (now chief engineer of the Gas Light and Coke Company), as consulting engineer. None of these firms continued a sufficient length of time to make a success of the system.

It will be noted that the United Gas Improvement Company, of Philadelphia, had then sole control of the process in the United States, and at this time (1890) came on the scene in England, and contracted with the Chartered Company, the Gas Light and Coke Company, of London, the largest single gas company in the world, to place them in a plant of 2,000,000 cubic feet daily capacity. This, mark you, was the first commercially successful plant erected in Europe. Mr. A. G. Glasgow represented the contractors, and during his stay in England his genial personality won for him many friends, among them Mr. Corbet Woodall.

Upon Mr. Glasgow's return, after completing the plant, he retained Mr. Corbet Woodall as consulting engineer, to look after his carburetted water gas interests in Europe. About 1892 Mr. Woodall placed in a plant at Copenhagen, Denmark, and had the work carried out by Mr. Glasgow.

Shortly after, or about the same time, the firm of Messrs. Humphreys & Glasgow was organized, Mr. Glasgow having previously left the United Gas Improvement Company and Mr. Humphreys leaving in 1893. Mr. Woodall was the instrument of bringing Messrs. Humphreys & Glasgow to Europe, and for a long time remained with them as their consulting engineer or adviser, and made it a point to introduce carburetted water gas plants wherever he possibly could, at various works in which he was on the board of directors, and at others for which he was consulting engineer; in fact, he never lost an opportunity of praising the merits of carburetted water gas, and its present strong position in Europe is due more to Mr. Woodall's enterprise than to any other single individual.

In 1894, the Economical Gas Apparatus Construction Company, Ltd., of Toronto, Canada, opened an office in London, with Mr. J. T. Westcott as Manager. About the same time Messrs. Samuel Cutler & Sons, one of the old firms of contracting gas engineers, of London, opened a department for the supply and erection of carburetted water gas plants. These three firms, with their agencies and connections throughout the world, have since been doing everything in their power to introduce these plants, with the result that at the present time the carburetted water gas plants in Europe have a total daily capacity of at least 152,770,000 cubic feet, subdivided into:

England	123,945,000	cubic feet.
Scotland	2,000,000	"
Ireland	8,200.000	"
The Continent	18,625,000	"

Plants are located in Denmark, Holland, Belgium, Germany, Switzerland and Sweden.

When the writer once asked Professor Unwin if his Technical College in Kensington was the same as the Stevens' Institute of Technology, in Hoboken, New Jersey, he replied that they were the same, with the exception of the difference which exists between things English and American; so the development of carburetted water gas in Europe has been similar to its development in America, except the different conditions existing between everything in the two countries, one of which, for the subject in hand, is the different climatical conditions. In Europe, gas house coke is used as fuel in the generators, instead of anthracite coal, as there is no deposits of anthracite in Europe similar to those of Pennsylvania.

The oil of the major portion of Europe has to be brought from a distance, whereas it is found on the spot in America.

The oils used have varied greatly, from the heavy oil of Russia to the light oils of America, with shale oil of Scotland and Germany, and a sprinkling of Borneo oil. To meet these various conditions the apparatus has been altered in detail of design from that used in America.

The question of the supply of gas oil was a serious one at first, as the different oil companies were not in a position to deliver gas oil at a cheap price, especially inland, although oil could be procured at seaport towns in bulk very reasonably. As the demand for oil has become greater, the methods of supply have also increased, until now the different oil companies are in a position to deliver oil at a reasonable price at any place in the United Kingdom, and at most places on the Continent.

The antagonism shown by many gas engineers against the introduction of carburetted water gas was characteristic of both Continents. This has gradually worn away until now some engineers formerly least in its favor have gradually altered their views until they have become its strongest supporters.

The much more rapid development of carburetted water gas in Great Britain over its development in Continental countries is due principally to the fact that as England is a free trade country, there is no duty on oil, whereas in many of the Continental countries, France, Spain, etc., there are two duties, the general government duty, and the civic or city duty, which is very high, and practically prohibits the use of oil for gas making purposes. In Belgium and Denmark the duty does not to any great extent interfere with the supply of gas oil; therefore, there are more plants proportionately. This also is true of Holland. In Germany they have a little native oil, and their free ports admit oil free of duty. Beyond this the taxes are a serious handicap to the introduction of carburetted water gas plants.

Anyone wishing to look further into the details of the development of the subject will find, by referring to advertisements in the different Gas Journals, that the development has been steady and gradual, and in the writer's opinion this is likely to continue.

Owing to a prejudice existing in certain minds as to the dangers of carburetted water gas, the Parliament of Great Britain appointed a Commission to investigate the subject, and they recommended that only a certain percentage of carburetted water gas should be mixed with coal gas.

They recommended among other things "That power should be conferred upon a central department to make regulations, enforcible by adequate penalties, limiting the proportion of carbonic oxide in the public gas supply to 12 per cent., or such greater amount as the department may consider desirable." From this it will be noted that the percentage of the mixture of carburetted water gas with coal gas would vary according to the percentage of CO in the two different gases. Although Parliament has not as yet passed any Act regulating the amount of carbonic oxide to be distributed to the consumers, yet it is a generally understood thing (one might say unwritten law) among the gas engineers of England, that they shall not send out more than about 25 per cent. of carburetted water gas mixed with their coal gas.

Like most rules it has had its exceptions, in that all percentages of carburetted water gas and coal gas have been distributed to the consumers, up to and including pure carburetted water gas, which has been exceptional, and only for a very short time. Many gas enterprises use their carburetted water gas plants only to carry them over the heavy days of the winter, shutting them down entirely during the summer months; other engineers use them continuously the whole year through; others only run intermittently during the day. They have been found of great convenience to many in times of sudden fogs and cold spells.

The local conditions of the country, its people and its resources and laws, have had much to do with the development of its industries, and this applies in a very marked degree to the progress of carburetted water gas plants, but we must not forget the assistance they have been in competing with the electric light, and the advantage they have been to modern enterprise, as a most valuable attribute in the formation of gas and oil trusts.

[Concluded from Page 88.]

Explosive Gas Mixtures.[1]

[Abstract Translation of a paper, read by Dr. H. BUNTE, of Carlsruhe, Germany, before the German Association of Gas and Water Engineers.]

In general, the danger from a mixture of gas and air, will be less the closer are the limits of explosion to one another, or, in other words, the smaller is the range or field of explosion. Now, it is possible to diminish the range of explosion by admixture of indifferent gases. Bunsen pointed out that carbonic acid was especially efficacious in this direction. Industrially, gases containing carbonic acid are found more particularly in the gaseous products of combustion from furnaces. These have more or less of atmospheric oxygen, amounting to 21 per cent. by volume, replaced by carbonic acid.

Ordinarily, the spent furnace gases from boiler furnaces contain 8 to 14 per cent. of carbonic acid, and those from furnaces in which gaseous fuel is employed 16 to 19 per cent. The latter would be peculiarly well adapted for mixing with explosive gaseous mixtures in order to do away with the chance of explosion. In gas engines, also, the exhaust gases, containing carbonic acid, are to some extent left in the cylinder and mix with the fresh explosive mixture which constitutes the next charge. It seemed, therefore, of interest to ascertain the limits of explosion of gaseous mixtures in which a portion of the oxygen is replaced by carbonic acid.

The results of researches in this direction, as carried out by Herren Eitner and Trautwein, are depicted in Diagram III., so far as they relate to coal gas and carbonic oxide. The abscissæ represents the percentages of combustible gas in the mixture; the ordinates, the amounts of carbonic acid in the mixture. The carbonic acid has displaced atmospheric oxygen. The diagram shows plainly that the range of explosion of the gas diminishes with an increase in the amount of carbonic acid present. As would be anticipated from the smaller amount of oxygen present in the mixtures, the diminution occurs chiefly at the upper limit of explosion, while there is only a slight shifting of the lower limit, as oxygen still remains in excess in that case. As soon as the upper and lower limit meets, no explosion can occur. It will be seen that the limits come together with about 7½ per cent. of carbonic acid in the mixture in the case of coal gas, and 10½ per cent. in the case of carbonic oxide. Under the experimental conditions observed in these researches, such mixtures cannot be exploded provided 7½ or 10½ per cent. of carbonic acid is present.

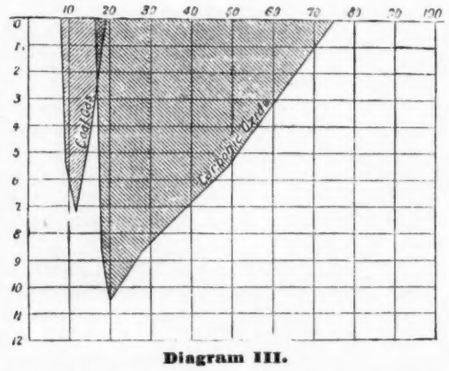


Diagram III.

One practical application which may be made of these facts, is when it is necessary to displace air by coal gas, as when new manufacturing plant, distributing mains, or gasholders have to be made ready for work. In all such cases, the formation of explosive mixtures of gas and air is unavoidable, though they may be of only brief existence; and it depends on the size and shape of the space filled with air whether

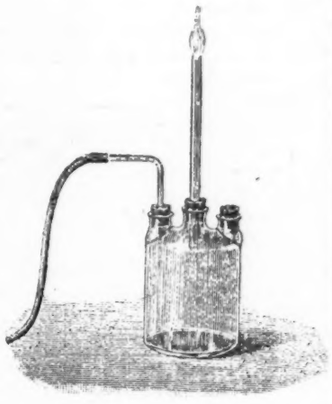
1. *Journal of Gas Lighting.*

the operation is attended with danger, and to what extent. But if the air is first of all displaced by the gaseous products of combustion from a furnace—with gas firing for choice—and the coal gas introduced only after this has been done, all chance of explosion is excluded, provided the mixture contains a certain amount of carbonic acid. As in practical cases the quantity of gas will be great, and the spaces large in comparison with the small dimensions of experimental apparatus, it would be advisable, in order to keep on the safe side, to raise the limit of carbonic acid from 7½ to 8 or 9 per cent.

The researches of Herren Eitner and Trautwein had already been concluded when the Municipal Authorities of Vienna approached the author with an inquiry as to how the new gas works and distributing system of that city should be made ready for work. On the strength of the researches referred to, and in consideration of the unprecedented problem and its attendant danger, the author strongly recommended the preliminary displacement of air by flue gases; and he is glad to say that the advice was followed. It appears to him highly desirable that this method of clearing out air by means of flue gases containing plenty of carbonic acid, should be employed in other instances before coal gas is admitted, as it can be properly carried out at little cost, so as to insure against any risk of explosion. The explosions which have occurred repeatedly in the first filling of new gasholders should serve as an express warning to use every possible precaution. Apart from the danger to life and property which is entailed, the whole gas industry suffers from the impression which a catastrophe of this nature creates on the general public; and the erection and extension of gas works consequently meet with opposition.

The study of the properties of explosive gas mixtures is attended with difficulties in several directions; and there are but few experiments connected with it which can be carried out before a large audience. The author, however, would recall some which serve to demonstrate the great importance of familiarity with the properties of such mixtures.

A 3-mouthed Woulff's bottle is fitted up as shown below and, as a precaution, surrounded by a cloth. The bent glass tube is connected with the gas supply and coal gas is allowed to pass into the bottle, while the air, or mixture of gas and air, escapes through the tube of about 0.4 inch in diameter, which is fitted into the middle mouth of the bottle by means of a cork. In a few seconds, the greater part of the air will have passed out, while the mixture within will have passed through first the lower explosion limit of about 8 per cent. of gas, and then the whole range of explosive mixtures ending at about 19 per cent. of gas. The mixture of gas and air, being no longer explosive, can then be ignited at the mouth of the tube. It gives at first the blue non-luminous flame, which will become luminous and smoky as the last residue of air is expelled by the gas. If the cork which closes the third mouth of the bottle is now removed, and the inflow of gas is stopped, air runs down the open mouth into the bottle, and mixes with the gas stored up there. The flame gradually decreases in size, and becomes non-luminous, with the characteristic inner green cone of the bunsen flame. At this point, the flame is formed from a mixture consisting of 35 to 25 per cent. of coal gas and 65 to 75 per cent. of air. The coal gas is mixed with about half the air requisite for its complete combustion, and the upper explosion limit is nearly reached. This is indicated by the flame becoming disturbed, and showing a tendency to spread downwards into the tube, against the continually weakening stream of gas. The rate of flow of the gas outwards is, however, still greater than the low rate of propagation of the ignition of the mixture, which is still relatively rich in gas. As soon, however, as, by the increasing admixture of air, the "detonating gas" limit (when there is about 17 per cent. of coal gas present) and the maximum speed of ignition are attained, the backward movement of the flame prevails, and a green ball of flame passes down the tube, and reaches the gas in the bottle itself, which thereupon explodes with a dull report. The flame of the burning gas rushes out of the openings of the bottle.



One very important property of explosive gas mixtures appears directly from this experiment. The greater the rate at which ignition is propagated, or the greater the time required to transfer ignition initiated at one point to the whole mass of gas, so much the more suddenly will the explosion ensue, and so much the more violent will be its mechanical effect. The precise measurement of this rate of ignition is attended with great difficulties, as a number of causes influence the results of experiments—such, not merely as the nature and proportion in the mixture of the gas, but also the temperature of the mixture, the presence of solid bodies having a cooling action, and whether the mixture is at rest or in motion. Different observers, using different methods, have therefore obtained different values. We are indebted to Mallard, Le Chatelier, Berthelot, and their pupils for the most important observations, from which the values that are used in Diagram IV. have for the most part been taken.

This diagram shows that the greatest rate of propagation or ignition is, for the mixture of air with hydrogen, 4.2 meters (13.8 feet); with marsh gas, 0.6 meter (1.97 feet); and with coal gas, 1.3 meters (4.26 feet) per second. These maximum rates do not, as might be expected, correspond precisely to the theoretical "detonating gas" mixtures, but are attained when there is a slight excess of the combustible gas. With dilution of the mixture, the rate of propagation diminishes, until, at the explosion limits, its value is *nil*. The normal rate of propagation can, however, as Berthelot first pointed out, be increased to the extraordinary extent of as much as 2,800 meters (9,190 feet) per second, more especially in closed service pipes, in which the gaseous mixture is highly compressed. The combustion of the gas then takes place with the peculiar explosion wave which can produce most violent mechanical effects, as has been observed in the case of many firedamp and gas explosions. It is clear that the pressure of the heated gases on the surroundings is greater the more suddenly their ignition occurs.

So long as the rate of propagation of the ignition remains within the normal limits of a few meters per second, the progress of the combustion can be perceived quite easily, as in the experiment already described. The propagation, backwards from the end of the tube, of the ignition of the gaseous mixture can be avoided, if the velocity with which the explosive gas mixture issues from the tube is made greater than the velocity of ignition. This can be readily demonstrated by proceeding as before, but, instead of allowing air to enter freely through the third mouth of the bottle, connecting that mouth to a powerful bellows, and blowing air in under pressure. The burning gas ball runs back momentarily into the tube, but is expelled again by the stream of gas; and the flame ts ultimately blown out without the gas in the bottle having been exploded.

The backward progress of the combustion can also be prevented by cooling the gas below the temperature of ignition. This can be done merely in the tube by which the gas passes out of the bottle. The narrower the tube is, the more powerful will be the cooling effect it will have on the flame; so that, at a certain diameter, no propagation of the normal combustion downwards will ensue. This can be readily demonstrated by substituting narrower tubes for the wide tube by which the gas issues from the bottle in the experiment described above. With a tube 4 millimeters (0.16 inch) in diameter, the ignition is propagated only an inch or so; and the flame is then extinguished by the cooling action, without the remaining gas being ignited. On diminishing the diameter of the tube to 2 millimeters (0.08 inch), combustion will no longer be propagated at all, even in the most inflammable gaseous mixture. On this observation, made more than 80 years ago, the safety lamp of Davy is based. The wire gauze used in this lamp constitutes in effect an aggregation of very many, very narrow and short tubes, through which the combustion cannot propagate itself to the exterior. This precaution naturally becomes of no avail, if among the thousands of holes in the gauze (930 to 1,225 per square inch) there is but one which exceeds the permissible size, or if the gauze has been injured or made red-hot, or if a violent movement of the air or gas has driven the gas flame through the gauze. The same principle has been applied in other directions as well as to the safety lamp.

It is clearly impossible, in a communication such as this, to enter into details, or to give practical directions, when conditions vary so greatly. The fundamental facts, however, as to the behavior of explosive gas mixtures put anyone in the position, to take, in each case, the proper means for avoiding catastrophes, or to elucidate the causes of accidents which may have occurred. But reference may be made to the important part which the facts referred to in the foregoing play in heating by gas, in lighting on the incandescent system, and in gas engines. In all gas heating apparatus and in incandescent gas burners, the principle of the Bunsen burner is applied—viz., the coal gas is mixed with a certain quantity of air before combustion. In heating appliances, this admixture of air is intended primarily to make the flame non-luminous, and to prevent blackening of the surfaces with which the flame comes in con-

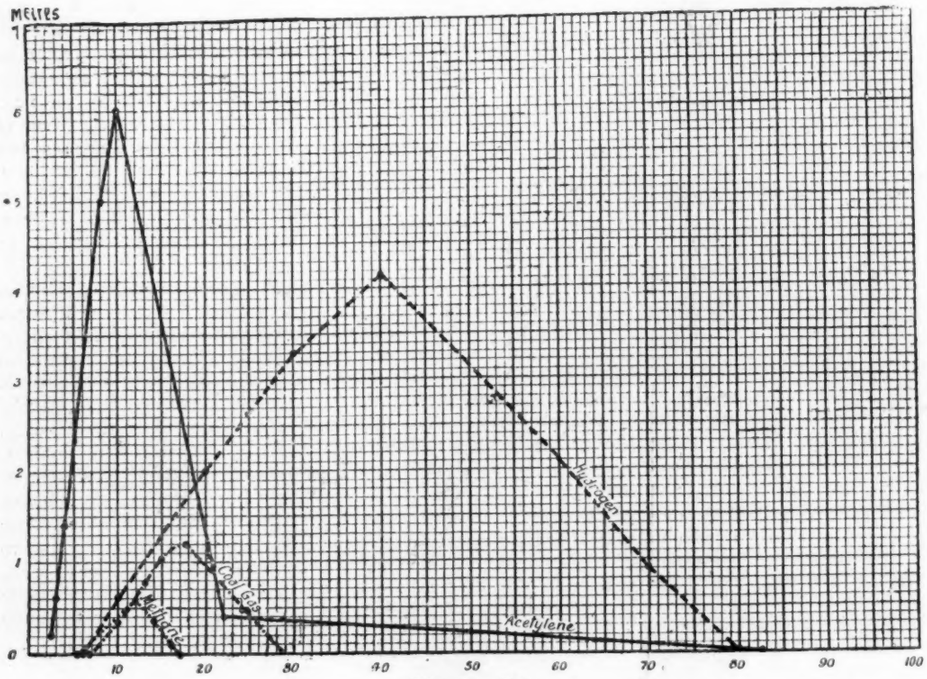


Diagram IV.

tact. But there is also the important question of promoting the complete and odorless combustion of the gas, even when cool metallic or other surfaces are played upon. This is attained the more thoroughly the more air is added to the gas before combustion, as Herren Haber and Weber showed in 1896. The admixture of air, however, is limited by the mixture of gas and air soon reaching the upper limit of explosibility (with about 20 per cent. of gas), when only about half of the air required for complete combustion is present. Thus practically not more than 2½ to 3 volumes of air to 1 volume of gas can be exceeded without—under ordinary conditions of gas pressure—the flame "striking back," which implies that the rate of outflow of the gas is less than the rate of propagation of the ignition backwards from the flame. But by increasing the pressure at which the gas flows out, by using gas under higher pressure, or by applying suction to it, the admixture of air to the gas can be considerably increased. It is well known that this is specially advantageous when applied to incandescent lighting apparatus, which it enables to concentrate the combustion in as small a space as possible, thereby affording the highest temperetures, and, consequently, the best development of light.

It goes without saying that the behavior of explosive gas mixtures is of supreme significance in gas engine construction. The development of these engines for the utilzation of the relatively poor gases from blast furnaces and gas producers rests on a better knowledge of the properties of such gases, of which carbonic oxide is the important constituent. But, while in gas heating apparatus it is generally necessary to keep above the upper limit of explosibility, it is the aim of the gas engine maker to keep as closely as he can to the lower limit, in order to accomplish as much motive work as possible with the smallest quantity of gas.

The violent explosions produced by mixtures rich in gas cannot be nearly so completely taken up by the moving parts of the engine, and utilized, as the slower explosions of the poorer gaseous mixtures.

The endeavor to consume mixtures poor in gas is favored by the circumstance, that, as already indicated, carbonic oxide, at high temperatures—such as prevail in the cylinder of a gas engine—and under a high degree of compression, has its range of explosion greatly extended downwards. Thus, in the more recent types of gas engines, it has been found possible to produce explosions with blast furnace gas containing but little carbonic oxide, and thereby obtain extraordinarily high motor duties, which could not be achieved under other conditions. The marvellous perfection of explosion engines which the last decade has witnessed arises from a better knowledge of the behavior of explosive gas mixtures—not, however, merely from purely scientific studies but from these supplemented by experiment as well as by practical experience. Practice, in this instance has forged very far ahead of scientific knowledge.

The author hopes that he has shown that the behavior of explosive gas mixtures, whether they be operating usefully or destructively, presents many applications in the gas industry and in gas engine works.

Some Common Faults In Exterior Illumination.

[A paper read by Mr. S. Everett Doane, at the last meeting of the Am. Inst. Elec. Engineers.]

General illumination can conveniently be considered from two points of view:

First—The actual distribution of light to the object illuminated.

Second—The value of this illumination to the observer.

We can accurately express the value of the first, but can speak only in general terms of the second.

Much has been said about the first and but little about the second, yet the second is the practical end for which all illumination is designed.

Whether or not the source of light is in range of the observer's vision largely influences the second value.

The contrast between the source of light and its environment is all important. A farmer's barn lantern will completely blind one to the road beyond when the night is black and the vicinity not otherwise illuminated, whereas an arc lamp backed by a white building may be a fairly satisfactory source of light.

I had occasion during many of the evenings last summer to ride over the country roads near my home, and I had plenty of occasion to notice their illumination. It was my observation that the best lighted towns in my vicinity used kerosene lamps situated at the side of the roads among the tree trunks.

Many and many a time when riding toward an arc lamp have I kept my place on a highway by guiding myself by the shining rail of the street railway track, absolutely unable to tell from the roadbed of shadows what was before me. Actual observations of this character make it clear that the amount of light really delivered to a roadbed is only a part of what we must consider.

If the source of light must from its character be so placed that the observer is blinded to the road, it avails little as to the candle power of that source.

An arc lamp usually must be so placed that its light may shine in one's face in order that the light may shine along the road.

Light delivered from a lamp near at hand is much to be preferred to light delivered from a lamp so far away that the rays of light reach the ground at a small angle. Such light magnifies every hummock and equally shadows insignificant hollows and gulleys deep enough to be dangerous.

It would be better to have half the illumination and be able to see the bottoms of the hollow spots.

One of the recent papers on arc lamps spoke of their value in illuminating the houses and trees, and presumably the landscape, where there are no houses and trees.

The interest in this observation lies in the thought that the greater the candle power, and the more infrequent the lamps, the smaller the portion of the total light shed upon the ground which actually reaches the roadway.

The Massachusetts State roads are uniformly 20 feet wide. The country roads rarely exceed 30 feet in width. City roads of Massachusetts are required to be 40 feet.

Arc lamps, located respectively 200 feet, 300 feet and 400 feet apart are evidently intended to illuminate plane areas about 31,500, 70,000 and 125,000 square feet in extent.

A 20-foot road crossing this area will receive about 12.7 per cent., 8.6 per cent. and 6.4 per cent. respectively of the light delivered to the ground.

A 40-foot road will receive twice this percentage, of course, but as the 20-foot width is all the average rider ever notices the illustration will answer.

From this it is very apparent why it is wise that lamps of reduced candle power be placed closely together.

From this same illustration it will be seen that lamps placed 200 feet apart, consuming one-half the energy, can be of one-half the efficiency and still give him equally efficient illumination and, what is more to the point, will deliver their light from a more advantageous direction.

One of the best illustrations of suburban street lighting by arc lamps which comes to my mind is on the Boulevard from Boston to Auburndale. The Boulevard is really two separate roads with a continuous narrow park between and the arc lamps are in the middle of this park, so that they may be said to be in a field adjoining the roads.

Why, with all these drawbacks, are arc lights used almost universally and incandescent lamps to so limited an extent?

I think there will be no discussion as to the reason. Incandescent lamps for street lighting have always been difficult to make and less satisfactory than any other type of incandescent lamp.

The ordinary 100-volt to 125-volt 16-candle power 3 l.w.p.c. incandescent lamp gives more candle hours for a given input than any other incandescent lamp. Could this lamp be used for street lighting the cost of street lighting by incandescent lamps could be materially reduced and the service rendered be much more satisfactory to the user of the highway.

There are many streets in which low voltage mains run the length of the streets and where these lamps could be used in multiple with no inconvenience. There are many other streets where 10 or 20 could be used in series, each on a cut out box, no more complicated than the Nernst lamp, which you will possibly be called upon to consider. These cut out boxes would not be so complicated as the arc lamps, which operate with practically no attention.

I do not understand why this has not been done.

Times have changed. The arc lamp lines are no longer the only wires on the poles. Probably one-half of the electric lighting poles carry alternating current mains also.

Incandescent lamps are now universally fastened to their bases by a waterproof cement, and waterproof sockets are in stock everywhere.

Is it not time we broke away from tradition?

The arc lamp has its use in street lighting. There are places where it is wisest to use it. The public think they are getting more for their money with the brilliant arc lamp, but I believe as the users of the highway come to appreciate how much safer and more satisfactory well placed illumination is than that to which I have referred, that we shall learn to light our streets as we do our homes.

The lesson learned in show window lighting and in theater stage lighting should not be lost upon us.

It is not the light after all that interests us; it is what we see by means of the light.

We must add to this that for a given expenditure of energy more light can actually be delivered to a highway by incandescent lamps than by arc lamps and it can better be distributed.

Arc lamps are at their best in densely settled districts. The reflected light from buildings helps to economize the distribution and the great quantity of light from store windows also assists to so brighten the surroundings that the brilliant arc lamp is less blinding. Arc lamps are also more closely spaced in these localities, which is to their advantage.

Incandescent lamps are, in my opinion, much to be preferred for residential streets, side streets and outside the more congested portions of a town or city.

Load Factors and Circuit Breakers.

[By An Engineer, in *Elec. Review.*]

It may have been observed that in the discussion of load factors any attempt to formulate a rule is based on the assumption that cars will not all start and stop simultaneously, and there appears a tendency to consider that there is a great probability of all the cars starting up together. Were this assumption true, the load factor for 100 cars would be exactly the same as that for only a single car; the same, that is, for the engine load, beyond the frictional resistance, and actually the same for the switchboard load. My own determination of load factor for a system of one car is from 10 to 12 per cent.; and if, on a system of 100 cars, every car did start and stop absolutely synchronously, the load factor could not exceed the same low figure. It has been argued that because the turn-outs of a tramway are laid out with a view to exact timing, this is the result attained; but I maintain that no such result can be secured by the most intelligent and careful calculation, for it is impossible to take into account the infinite personal matters that interfere with the attainment of a calculated effort.

A close approximation to practically perfect car running may be secured without in the least interfering with the load factors as determined by the formula I have suggested. A difference of a few seconds only in the starting of a dozen cars will be quite sufficient to reduce starting currents to a moderate aggregate figure. Actual autographic records of the current consumption of cars started from rest do not show an initial rush of current on the first controller notch of any particular severity. Indeed, it appears from numerous records that the first series notch allows less current to pass with a car starting from rest than will be consumed by a running car on the parallel notches. The jump to the parallel running first notch is larger than the jump from zero to the first series notch.

A very slight incident will disturb the synchronous starting of a lot of cars. The presence or absence of passengers, the delivery of a parcel by the conductor, or the slow movement of a stout passenger, will serve to throw cars out of time. Observation of the switchboard instruments of numerous tramways, and of the autographic tapes, will show conclusively that the load factor does naturally and markedly improve with the number of cars at work. It is not denied that there is an occasional flush of current that would, perhaps once, perhaps ten times daily, show a maximum load far beyond anything covered by the load factors I have sketched out. I italicize "*would*" designedly, because these heavy currents do not require to be allowed for in practical working. The maximum load that practice has decided upon as allowable, and as really determining the load factor, is that which can be suffered to occur many times daily. Any further maximum is disallowed by the main circuit breaker, for this is set to act in a way to forbid the severe effects of an occasional simultaneous starting of many cars. These simultaneous startings are more apt to occur when cars are fewer, and embrace a larger proportion of the total load, and this is why it is that circuit breakers must be set proportionately higher for few than for many cars.

Too much stress, also, must not be laid upon the effects of starting current in producing a heavy station load. The starting current on the first series notch of a controller is not above 10 or 15 amperes in a single truck car on a level, and is of less moment than the sudden jump which takes place when the controller handle is passed to the first parallel from the last series notch. Now, this operation is performed many times, as a rule, between each start of a car from rest, and has a greater effect on station output. It is obviously very unlikely that cars will synchronize either on starting times or in parallell working, and, therefore, with judicious fixing of the automatic cut-out, the maximum station output is controlled within selected reasonable limits. The setting of the main cut-out is not usually accorded much serious thought. It is, however, a matter of real importance. If set too low the cut-out will act too often; cars will constantly find themselves without current, and the engines will be too frequently running at no load. The load factor will be improved if the circuit breaker is quickly put in, as it should be, for, in most cases, the acting of the breaker is due to causes that are momentary in effect. On the other hand, when circuit breakers are set unjustifiably high they will rarely act, and will expose the machinery to unnecessary and undesirably high stresses. At the same time the load factor will be reduced and the economy of the station impaired.

Between these two extremes there is a point at which the instrument should be set by experiment. It should always be set low to begin with—that is to say, it may be set to act when the current is from 50 to 30 amperes per running car, according to the size of the station. If, with the first setting, it acts too frequently for the convenient working of the station, it may then be screwed up to a higher pitch, but not so high that it ceases to work from time to time. When fairly adjusted, the instrument fulfils the double purpose of safeguarding the machinery and pointing out unusual shorts.

In working out load factors, it does not appear possible to work upon any assumption as regards turn-outs or simultaneous starts, or indeed, on anything of the nature of mere assumption; but it appears rational to base calculations upon approved averages. From careful observations upon a considerable number of running tramways extending over many months, it is apparent that the mean average of all conditions on numerous lines of very different types, working under conditions as widely different as will usually obtain, is remarkably amenable to calculation by purely empirical methods. Variations will, of course, occur in different systems, due to different settings of the main circuit breaker, but such variations are not so wide as seriously to impair the value of an approximate formula. It is for this reason that car hours and the average number of running cars should be known, for these figures are of more engineering value, if indeed, not of more financial value, than mere car mileage. Car mileage and units consumed per car mile are usual statistics to be given, but they are of

small value taken alone. Unless car hours are known, the mean speed of the cars cannot be ascertained, and it is impossible to draw conclusions from the units per car mile.

The loss of energy due to frequent stops accounts for a considerable proportion of energy consumption, and it by no means follows that a high average speed implies more units per car mile, the tendency, perhaps, being rather the other way, owing to the conservation of energy otherwise dissipated by frequent braking.

To sum up, while the heavier draughts of current by several cars may occasionally synchronize, all such efforts are preferably to be eliminated by the action of the circuit breaker, this serving to cut off the high spikes of the autographic record, and reduce the maximum flow of current to such a multiple of the mean current as practice has shown to be reasonably consistent with convenience of working, and the safety of the station. The circuit breaker, in fact, seems to effect the best compromise between opposing interests.

The importance of a fairly approximate prognosis of the load factor, and the average current per car, extends beyond the design and provision of the station outfit, for upon it hangs largely the design and copper contents of the distribution system, and, indeed, the whole general economy of the system and works. The rapidly augmenting weight of later cars will materially affect total current consumption, but probably it will have but small effect upon the load factor, seeing that this is dependent upon the number of individual loads, rather than upon the size of such loads. Still it is desirable that statistics should be kept and made available for all running systems, showing all the conditions and the power consumption, car hours and mileages, etc., without which knowledge design must be more or less a matter of guesswork. That guesswork has been one of the main factors in power station design is very evident when stations are compared and their working figures studied.

The very perfunctory attention at times accorded to the circuit breaker is evidence that its proper and complete functions are not always understood as they should be. A circuit breaker is too often regarded simply as a device for taking care of short circuits and cable damages. Quite as important is it that it should cut off what would be the excessive spikes of the load diagram. Though the general maximum load will be that which occurs frequently and almost periodically, and should not start the circuit breaker, there will be occasional car coincidences in respect of heavy demands of current that must be eliminated. It is not desirable that on an up-grade of considerable angle a car should be deprived of power. It is, therefore, right that lines of severe gradients should be allowed a higher maximum current than is proper to more level systems. This necessity is moderated by the fact that the excess of up-grade car demands is more or less balanced by the down-grade cars; but it is probably on the side of safety to allow a poorer load factor in hilly country, as safety is better insured thereby. This need not necessitate any special calculation, as the proper allowance will be secured by experiment, the circuit breaker being adjusted to the conditions that show themselves when a line is set to work.

If the arguments here advanced have a sound basis, it is evident that there is a close connection between the load factor and the circuit breaker, and that judgment is necessary in estimating the limit of economy at which a station can be suffered to work without impairing its convenience or its safety.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, ENGLAND, January 10th, 1902.

The Affairs of the Welsbach Company.—The Height of the Mercury and the Consumption of Gas.

Last July, under the heading of "A large trade and no profits," I dealt with the affairs of the Welsbach Company, and some of the reasons why, with an annual turnover of 1,000,000 burners and 8,000,000 mantles, sold at high prices under the protecting wing of the patent laws, there was no balance available for dividends. The appointment of an advisory committee was then referred to, and this committee consisted of some of the best business men of the day. They have concluded their investigations and set forth the results in a lengthy report comprising 53 paragraphs. The directors do not accept their recommendations and have issued an equally lengthy rejoinder. The whole matter is to be submitted for consideration at an extraordinary meeting of the shareholders, to be held in a few days, and as the committee and the board are at absolute variance, the proceedings will present a nice little game of "pull devil pull baker" between the respective partisans of the two bodies.

In view of the opinions expressed 6 months ago, it is interesting to refer to the advisory committee's report, which sets forth (par. 5) that the investigation has been of an arduous character involving the examination of the directors and principal officers of the Company, a large number of experts, representatives of the wholesale and retail trade, and the consideration of an immense mass of documentary evidence. After following up the formation and capital of the concern the committee state (par. 11): "We are of opinion that the Company has been enormously over capitalized and that the properties transferred to the Welsbach Company were so transferred at a grosly exaggerated value." Again (par. 13): "The committee find that the undue inflation of capital has been one of the contributing causes of the difficulties into which the Company has fallen." With regard to the patents, patent rights and goodwill acquired by the Company at a cost of 1¾ millions sterling the committee are of opinion (par. 15): "That these patent rights cannot represent, except to the most limited and reduced amount, any appreciable portion of the large sum that was paid for them." The large expenditure on litigation is referred to (par. 17) as bringing no commensurate benefit, and the committee state that the goodwill of the Company can and ought to have been upheld by a vigorous commercial policy rather than by endless procedure in the law courts. They consider (par. 18) that the future success must depend upon the operations being conducted on a sound commercial basis, and the production of the best quality at the lowest cost, with a view to large popular sales at a fair margin of profit. To the neglect of this elementary business principle, and to the unwise policy of relying too exclusively upon a protected monopoly, the misfortunes of the Company are largely due. The committee approve the reduction of prices made in June, 1900, and believe it will be necessary to move further in this direction, and to revise the present selling arrangements. Competition and infringement can be more effectually checked by popularizing the mantles. The committee have been carefully into the cost of production but do not think it wise to give particulars of this in a published report, but they believe that under improved organization and proper management the present output could be more than doubled. After reviewing the details of management, and interests in other enterprises at full length, the committee quote the opinion of Mr. Geo. Livesey that the future of the gas industry depends upon the increased employment of gas for cooking and heating and upon the more extended use of incandescent mantles for lighting, and advocate that as far as possible the policy of the Welsbach Company should be in co-operation with that of the great gas companies.

The reply of the directors is decidedly antagonistic to the committee, and an attempt is made to discredit their recommendations, while they are also blamed for hampering the daily operation of the Company. The shareholders are freely given to understand that while the advice of the committee is of no practical value the affairs in many respects have been kept at a standstill during the time occupied by their investigation, and the directors endeavor to show, as is only natural, that they are quite able to conduct the affairs of the Company without the help of an advisory committee. The greater portion of their reply is, of course, of particular rather than of general interest, but their answer to the suggestion of a more friendly attitude towards the gas industry is remarkable, and serves to some extent to explain their actions in the past. Their opinions on this head are so extraordinary that they must be quoted in full: "It is to be regretted that no member of the committee has had any experience of a practical nature in gas enterprise, and especially in incandescent lighting; for otherwise they would have known that experience has shown that the attitude of most gas companies to all forms of gas economies has been one of either active or passive hostility. The directors cannot too strongly deprecate the suggestion that the Company should place its interests mainly in the hands of the gas companies who would neither push sales or recommend mantles, except to increase the consumption and sale of gas in competition with the electric light, and then only on their own terms. The goodwill of the Welsbach business depends upon the goodwill and active co-operation of the gas trade as distinct from the gas companies."

The directors of the Welsbach Company seem to suspect the gas companies, and to think that they also desire to maintain the price of their commodity by artificial means, and in this respect they exhibit an ignorance of fact that is simply ludicrous when compared with "experience of a practical nature in gas enterprise," which it may be assumed they claim to possess. The chief form of "gas economizer" is a low price, and gas companies, so far from exhibiting either passive or active

hostility towards low prices, have long since recognized the principle recommended by the committee, but repudiated by the directorate, of selling at the lowest possible price. The prosperity and stability of the gas industry in England may be said to date from the time when, thanks to efficient legislation, watered capital became a practical impossibility, and a similar experience is awaiting the Welsbach Company. But one is tempted to inquire further as to why the directors should be willing to do anything to conciliate the trade, while they ignore "the companies." Gas companies are very large customers. The quantity of mantles required for public lighting only is not inconsiderable. In addition to this many gas companies are undertaking maintenance; and it would be interesting to know how much of the rapidly increasing sales, the credit for which the directors are not averse to ascribe to their own superior management, is due to the companies and "the trade" respectively. But gas companies are not in the position of being able to prosecute users of oil or electricity for infringement; and, therefore, they call for a cheap mantle, and will eventually have it—from the Welsbach Company, perhaps, if the advisory committee carry their points, if not, from other makers. The "trade," on the other hand, being entitled to discount on all materials sold, have no special anxiety for a cheap mantle. So a reasonable explanation of this remarkable preference for "the trade" rather than "the companies" is that the former are not likely to worry for reduced prices while gas companies, most of whom undertake maintenance in one form or another, are likely to ask why they should be expected to pay twice as much as is charged in other countries. The directors are like ostriches burying their heads in the sand and "their practical experiences in gas enterprise" dates about half a century back. The advisory committee have a better grip on modern conditions of business. No other manufacturers of gas appliances have found it necessary to draw invidious distinctions, or to attempt to win the favor of "the trade," and the directors are badly advised in going out of their way to make reflections upon a good, substantial line of customers, who, whatever their failings, are usually able to earn something for the shareholders.

The weather prophets have again proved to be wrong, which is no unusual thing. We were led to expect a very severe winter, and about the beginning of last month it seemed likely that these anticipations would be fulfilled. A few days before Christmas, however, a change came, and since then all frost has disappeared, the south wind has been blowing, and the climatic conditions more like April than January. The effect on sales of gas and of coke is very marked. Both were booming while the frost was on, but are now very quiet, and we again have a marked illustration of the connection between the state of the thermometer and the demand for gas, and it is evident that the extended introduction of the gas fire is responsible for creating sudden and unlooked-for variations in the daily consumption to the extent of 20 per cent. or so, and for increasing the anxieties of the gas works manager in a like proportion. Most of us would, if we had our choice, take the severe weather after Christmas. But when it had come, and all the machinery was put into operation to meet it, we would rather that its force was expended and done with, than that it should depart for a few weeks, only to return as suddenly as it went away. These variations also suggest an important consideration with regard to the extended use of gas for fuel. The convenience and efficiency of gas for this purpose are generally admitted, but on account of financial considerations the present applications of gas as a fuel are of a fragmentary and limited kind. The price is such that it cannot compete with solid fuel except under special circumstances, such as intermittent use, or where the services of an attendant to look after the coal fire is required, or in offices and drawing rooms where the frequent presence of domestics is an inconvenience. But if, under the present condition of a very partial use of gas for heating, the variations in the height of the mercury in the barometer from day to day are sufficient to affect the consumption to the extent of 20 per cent., what may be expected if the prophecy, oft repeated, is fulfilled and gas is sold at a price that secures its general adoption in place of solid fuel? Under such circumstances, what would be the difference in demand, expressed in percentages, in the third week in December, when clear, frosty weather prevailed, and the comparatively mild weather experienced since the beginning of the new year.

The present condition cannot be handled comfortably with less storage than that equivalent to 24 hours' maximum demand, and how many hours' storage would be required for a universal gaseous fuel. Or to put the matter another way, the demand, during a week of exceptionally cold weather will amount to $\frac{1}{7}$th of the total annual consumption, and under the new conditions would come nearer to $\frac{1}{2}\frac{1}{0}$th. It is evident that a very large storage reserve would be indispensable to reliability of supply, and that, if storage was dispensed with, as has been proposed, a generating plant equal to the maximum demand would be of such magnitude as to represent three times the actual annual production, and would, therefore, be on the slow working during the greater part of the year.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. J. F. PORTER, President of the Alton (Ills.) Gas and Electric Company, informs us that his Company is in the market for a double-lift gasholder, of about 100,000 cubic feet capacity. Communications respecting this may be addressed to Mr. Porter.

THE syndicate headed by Messrs. Bertron & Storrs, of this city, has secured by purchase the properties of the Leavenworth (Kas.) Light and Heating Company, and will hereafter operate the same. The works will be rebuilt, and the gas manufacturing division of the enterprise has been put in charge of Mr. Robert C. Calhoun, formerly at Bay City, Mich.

AT the annual meeting of the stockholders of the Houston (Tex.) Gas Light Company the following officers were elected: Directors, T. W. House, T. H. Scanlan, Henry S. Fox, James A. Baker, Jr., and J. B. House; President, T. W. House; Vice-President, T. H. Scanlan; Secretary, Treasurer and General Manager, John Shearn; Superintendent, J. H. Fitzgerald.

THE formal transfer of the Pontiac (Mich.) Gas and Electric Company to the Pontiac Light Company, which is controlled by Messrs. H. D. Walbridge, W. H. Morgans and their associates, has been made. It has been determined to put the selling rate at $1.25 per 1,000 cubic feet, prompt payment to entitle the user to a rebate of 25 cents per 1,000. The concession is to take effect May 1st.

MR. HERBERT S. SHAW, Treasurer of the Webster (Mass.) Electric Company, and Manager of the Peoples Light and Power Company, of Danielson, Conn., has been appointed Manager of the Spencer (Mass.) Gas Company.

AT the annual meeting of the Cicero (Ills.) Gas Company no change was made in the executive management.

THE Western Gas Construction Company has just closed a contract to instal for the Detroit City Gas Company the necessary exhausting, tar extracting, washing and scrubbing apparatus for a coal gas plant up to a per diem output of 1,500,000 cubic feet. The Western Company's system of condensation is to be employed, and it will include the Holmes "New" rotary scrubber. The "Westerners" say that this outfit will be the most up-to-date coal gas plant in the United States, when finished. A third order for duplex purifiers has also been placed with the Construction Company for two 20 by 24 by 11 feet 6-inch boxes operated by the Western duplex valve. It will also furnish all of the iron work for 32 benches of 9's and 8 benches of 6's.

AT a recent meeting of the New Orleans (La.) Gas Light Company the following Directors were elected: A. H. Siewerd, R. M. O'Brien, Aldin McLellan, A. Baldwin, A. B. Wheeler, D. M. Kilpatrick and John Stumpf.

AT a special meeting of the shareholders of the Rockville (Conn.) Gas and Electric Company it was voted to issue $25,000 additional cumulative 6 per cent. preferred stock. The proceeds of the issue are to be employed to retire the floating indebtedness.

BILL No. 175, New York Assembly, declares that it shall be a misdemeanor for any person or corporation in the city of New York to ask, demand or receive a deposit of any sum as security for gas or for security for meters.

"W. G. M." is informed that the annual meeting of the Washington (D. C.) Gas Light Company will be held at noon of the 3d prox.

A CORRESPONDENT informs us that Mr. W. A. Bixby, Manager of the Decatur (Ills.) Gas and Electric Company, has been appointed engineer to the Peru-La Salle (Ills.) Gas Light and Power Company, which properties were recently purchased by the owners of the lighting companies in Galesburg, Danville and Champaign, Ills. It has been decided to purchase a site whereon to construct a complete, new modern

gas works and an electric lighting station, and Mr. Bixby is now engaged in preparing plans for a combined coal and water gas generating system of a capacity up to 300,000 cubic feet per diem. The apparatus will include a complete set of exhausting, condensing, scrubbing and purifying vessels, and a storage holder to rest in steel tank, up to retaining 100,000 cubic feet. In connection with the La Salle betterments, Mr. Bixby is considering the installation of a water gas plant at Danville and Champaign, and the proposition also covers a holder of 100,000 cubic feet capacity for the first named place. All the named properties are within a radius of 100 miles of Decatur, where Mr. Bixby will retain his headquarters and continue in the management of the Decatur works.

Representative Leahy, of Boston, has put before the Massachusetts Legislature a bill which directs that "No gas company doing business within the commonwealth, or hereafter to be organized, shall require a deposit of money or other thing of value as a guarantee of the payment of any bill for the consumption of gas."

The Business Men's Association, of Ithaca, N. Y., is urging the advisability of purchasing the plants of the local gas and water companies for operation on municipal account.

The Kansas City, Mo., Gas Company has paid into the city treasury the sum of $7,208.87, which sum represents 2 per cent. on the Company's gross earnings for the 6 months ended December 31, 1901.

"T. S. J.," writing to the Journal under date of the 21st inst., says: "I note your reference in the issue dated yesterday to the application made by the Cuyahoga Gas Light Company for the right to supply gas in Collinwood, which is in reality a suburb of Cleveland. Other applicants for the franchise were in the field, and I think I am safe in saying that the action of the Council granting the right for the district to the Cleveland Gas Light and Coke Company will be sustained. The Cleveland Company agrees to supply gas in Collinwood at the rate of 70 cents per 1,000, and to pay into the village treasury the sum of 6½ per cent. per annum on the gross receipts. The franchise is to run for 25 years, and it is stipulated that the placing of the main pipes shall be commenced not later than May 15th.

Mayor Llewelling, of Harvey, Ills., has signed the franchise under which Mr. Clarence H. Geist, of Blue Island, Ills., is authorized to supply gas in the named place. The franchise is to run for 40 years. Ordinances of a similar nature have been secured by Mr. Geist for the supplying of gas to the residents of Blue Island and Morgan Park. It is stipulated that gas must be supplied through 8 miles of mains, connected with a suitable manufacturing plant, which latter must be completed within 15 months from the signing of the grants. Geist's plan is to erect a works on the Little Calumet river, near Harvey, to supply the entire district, a separate holder for the Morgan Park section having been arranged for. He also declares that in time he will pipe gas from Harvey to Chicago Heights, which place is 10 miles south of the first named. In that stretch he will be able to put gas in the intervening hamlets of Hazle Crest, Homewood and Flossmoor.

Mr. John J. Cummins, General Manager of the Syracuse (N. Y.) Lighting Company, has planned notable improvements on the gas and electric lighting plants of that city, which recently have come under the complete control of those heretofore in ownership of the Gas Company. It is thought that the new construction (as between manufacturing plant and main extensions) will involve an expenditure of $300,000.

The works of the Indianapolis (Ind.) Gas Company are to be reconstructed, under plans prepared by Mr. James Somerville, whose ability to direct successfully an operation of the sort underway may not be questioned. We understand that the plant (its model will likely be of the combined type) will be up to an output of 5,000,000 cubic feet per diem. One item in the construction is a holder, rated to retain not less than 3,000,000 cubic feet.

The franchise of the North Jersey Gas Company, which was formed for the purpose of supplying gas in the district of Paterson, N. J., and places contiguous thereto, has been annulled by virtue of a decree made by Judge Dixon, of the New Jersey Supreme Court. The concern had a nominal capital of $1,000,000, but it was shown on the trial hearing that the paid-up capital amounted to $250.

F. O. Frazier and others have applied to the authorities of Redondo, Cal., for the right to there operate a gas works.

At the annual meeting of the shareholders in the Newburyport (Mass.) Gas and Electric Company, no mention of a pending change in the ownership of the concern was made. A semi-annual dividend of 2½ per cent. was declared, and the officers elected were: Directors, Wm R. Johnson, L. B. Cushing. T. C. Simpson, Samuel March, E. P. Dodge, N. N. Jones and D. D. Tilton; President, W. R. Johnson; Clerk and Treasurer, D. D. Tilton.

In the changes that have occurred in the management of the Willimantic (Conn.) Gas and Electric Company, through purchases made by capitalists heretofore not interested in its fortunes, the following executive management is reported: President, Jas. F. Church; Secretary, Edward F. Evans; Treasurer, George F. Lewis. Mr. Evans is in charge of the manufacturing divisions.

It seems to be a settled fact that the Rivershore Gas Company, which supplies gas to the boroughs of Riverton, Palmyra, Riverside and Moorestown, N. J., is to be absorbed by the South Jersey Gas, Electric and Traction Company.

At the annual meeting of the South Jersey Gas, Electric and Traction Company, of Trenton, N. J., the following officers were chosen: Directors, A. R. Kuser, T. N. McCarter, Wm. J. Bradley, Uzal H. McCarter, F. F. Dryden, Jno. L. Kuser, W. J. Thomson, J. J. Burleigh, H. W. Johnson, Charles Watson, Frank Bergen, Thos. C. Barr, Barker Gummere, F. O. Briggs, H. C. Moore, Richard Stockton, J. H. Blackwell, Wm. L. Elkins, Jr., Stephen Peabody and Robt. C. Pruyn; President, A. R. Kuser; Assistant to President, Richard Stockton; Vice-President, William J. Bradley; Treasurer, Charles G. Cook—the latter, who was formerly Assistant Treasurer, succeeds Mr. McCarter as Treasurer, who has accepted the appointment of counsel to the Company.

The plans for the reorganization of the Gas and Electric Company, of Bergen county, N. J., are in a forward stage. It is likely that Mr. Edwin Gould will be elected President of the reorganized corporation, which is to be known as the Bergen Company. The liabilities of the original concern are thus stated: Common stock, par value, $2,000,000; first mortgage bonds, $1,500,000; debenture bonds, $600,000; floating indebtedness, $100,000. There has been no friction whatever so far in tentative arrangements for the rehabilitation of the property.

At the annual meeting of the Williamsport (Pa.) Gas Company the following officers were chosen: Directors, H. E. Gawtry, J. B. Bailey, H. C. McCormick, Jno. G. Reading, H. R. Wilson, T. W. Stevens, Frank Tilford, F. S. Male and L. B. Gawtry; President, H E. Gawtry; Vice-President, H. C. McCormick; Treasurer, T. W. Stevens; Secretary, L. B. Gawtry.

It looks that Deadwood, South Dakota, is to have a gas plant. In any event a franchise for the Black Hills Gas, Light and Fuel Company has been granted to Messrs. C. T. Tenny, C. J. Colby, Jno. R. Wilson, Neil McDonough and R. P. Stewart. They declare that a site for the works has been purchased and that gas will be in use in Deadwood by July 1st.

The Hudson County (N. J.) Gas Company has been authorized by the authorities of Fort Lee, N. J., to place its mains in the streets of that borough.

At the annual meeting of the Waynesboro (Pa.) Gas Company the officers elected were: President, W. H. Brown; Treasurer, J. M. Wolff; Secretary and General Manager, T. B. Smith; Superintendent, J. N. Stickell.

The American Blower Company, of Detroit, Mich., recently produced a fan of unusual dimensions to be used in a mechanical draft installation. It is intended for producing forced draft in a boiler plant of 10,000-horse power, and does away with the use of a chimney. The fan will be used in connection with Roney stokers, the fuel employed being anthracite buckwheat No. 2. It has a wheel 18 feet in diameter, inclosed in a housing constructed of steel plate and beams, standing 30 feet high.

Mr. A. H. Payson, formerly Vice-President of the San Francisco Gas and Electric Company, is now acting President thereof, vice Mr. J. B. Crockett, resigned.

The Market for Gas Securities.

There was quite an upward move in Consolidated in the week, and not a few transactions were recorded. The closing to-day (Friday) was made at 217 to 218½. Gossip, or tattle, or chatter, according to one's taste for light speeches, is busy with the thought that the deal between the financial giants for control in the Brooklyn Union Company is again in the warm stage. This is more apparent than real, for were the negotiations near the concluding point, Brooklyn Union would be at least 50 points higher than those quoted for it to-day—213 to 217.

Peoples, of Chicago, is again above par mark, and Lacledes are strong. Washington (D. C.) gas dropped a trifle of 10 points in the week. Baltimore holds its own, and Cincinnati Gas and Electric is bid 100½, even in the face of the proposed issue of another million of stock at par. The American Light and Traction Company has declared a dividend of 1½ per cent. on its preferred stock, for the quarter ended the 31st ult. It is payable February 15th. The situation in San Francisco remains decidedly mixed.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 Wall Street, New York City.

January 27.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	217	218½
Central Union, Bonds, 5's.	3,000,000	1,000	109½	111
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	115	118
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	310	315
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co. Bonds, 5's	11,000,000	1,000	109½	109¾
Northern Union, Bonds, 5's.	1,250,000	1,000	106	108
New York and East River. Bonds 1st 5's	3,500,000	1,000	111	115
" 1st Con. 5's	1,500,000	..	109	111
Richmond Co., S. I.	348,650	50	100	..
" Bonds	100,000	1,000	103	..
Standard.	5,000,000	100	130	135
Preferred	5,000,000	100	150	155
Bonds, 1st Mortgage, 5's	1,500,000	1,000	118	..
Yonkers	299,620	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	213	217
" " Bonds (5's)	15 000,000	1,000	119	119½
Bay State	50,000,000	50	⅝	¾
" Income Bonds	2,000,000	1,000	.	75
Binghamton Gas Works	450,000	100	28	30
" 1st Mtg. 5's	509,000	1,000	93	96
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	8½	10
" " Bonds, 5's	5,250,000	1,000	79	80½
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	
Central San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co.	29,500,000	100	100½	101½
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	106	107
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	60	65
Preferred	3,026,500	100	84	86
Consumers. Jersey City Bonds	600,000	1,000	102	103
Consumers, Toronto	1,700,000	50	218	225
Consolidated. Baltimore	11,000,000	100	62¾	63¾
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's.	1,000,000	..	..	..
Equitable, 1st 6's.	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	12	14
" Con. Mtg. 5's	380,000	1,000	79	83
Consolidated G. & E. Co.'s., Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co.	4,825,500	50		89
" Prior Lien 5's	5,603,000	1,000	99½	100
Detroit Gas Co., 5's	381,000	1,000	89	89½
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	34	38
Fort Wayne	2,000,000	..	..	.
" Bonds	2,000,000	..	53	55
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	102	104
Hartford	750,000	25	245	265
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	60	64
" Bonds, 6's	2 650,000	..	99½	101½
Jackson Gas Co.	250,000	50	68	71
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	..	92½
Preferred	2,500,000	100	108	110
Bonds	10,000,000	1,000	..	108½
Lafayette Gas Co., Ind.	1,000,000	100		60
Bonds	1,000,000	1,000	48	55
Louisville	2,570,000	50	110	120
Madison Gas & Elec. Co. " 1st Mtg. 6's	350,000	1,000	107½	109½
" 6 per cent. scrip, due 1910	100,000	25	25	87
Montreal, Canada	2,000,000	100	182	184¾
Newark, N. J., Con. Gas Co Bonds, 6's	6,000,000	..	..	55
New Haven	4,600,000	..	..	103
Nashville Gas Lt. Co.	1,000,000	25	300	325
Oakland, Cal.	1,000,000	100	110	..
" Bonds	2,000,000	..	46	47
Peoples G. L. & Coke Co., of Chicago	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	25,000,000	100	101¼	101½
2d "	20,100,000	1,000	..	..
Rochester Gas & Elec. Co.	2,500,000	1,000	104	
Preferred	2,150,000	50	88	..
Consolidated 5's	2,150,000	50	118	..
San Francisco, Cal.	2,000,000	.	87½	90
	10,000,000	100	44	44¾

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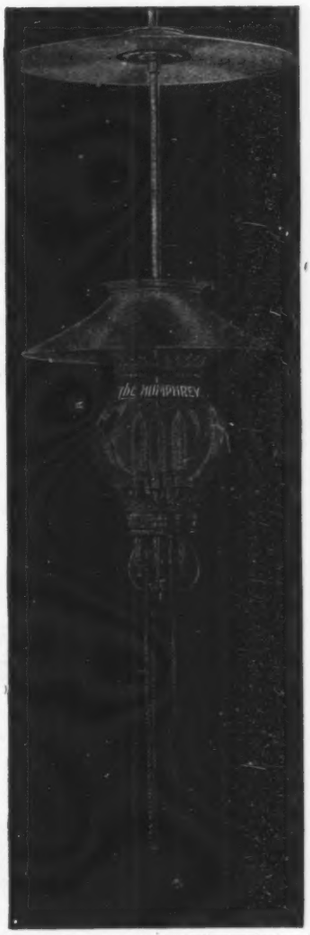

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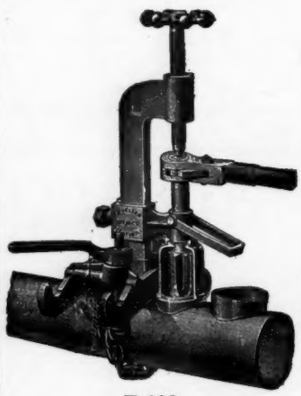

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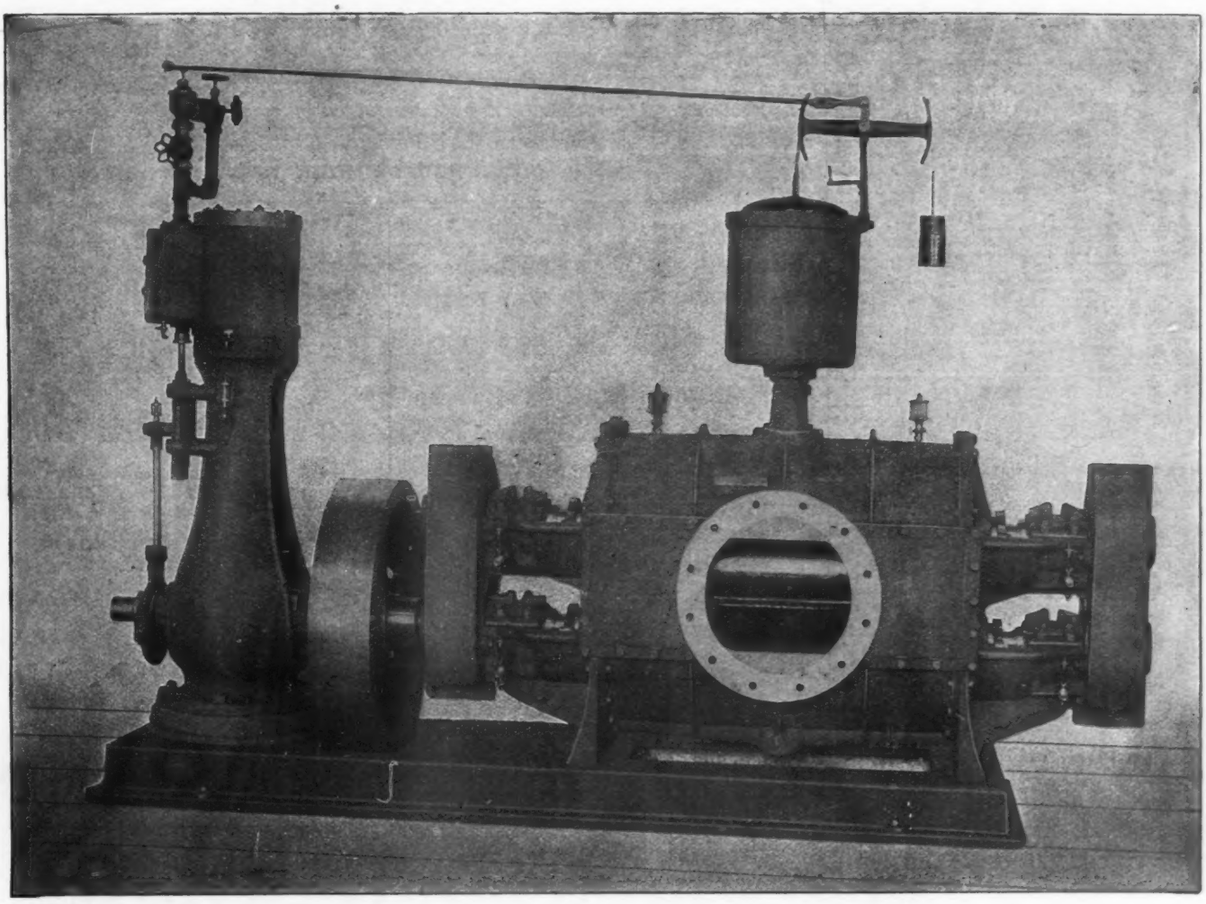

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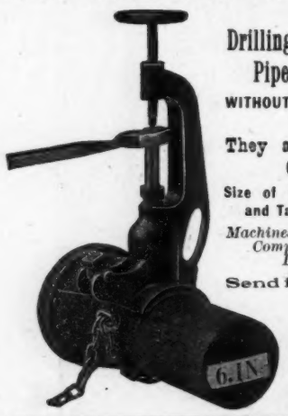

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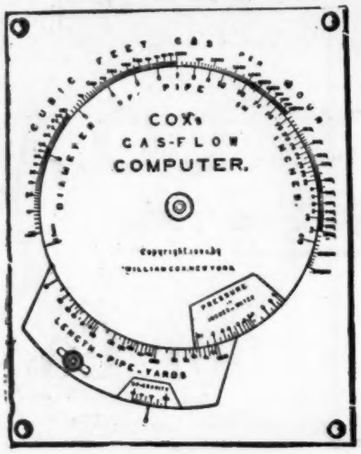

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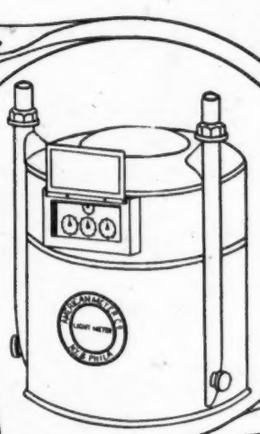

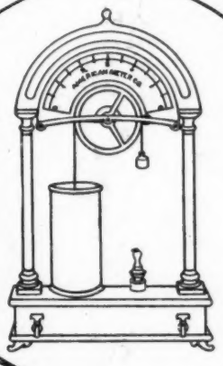

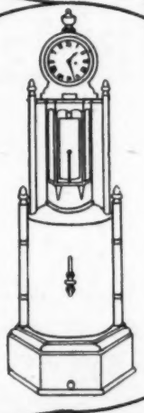

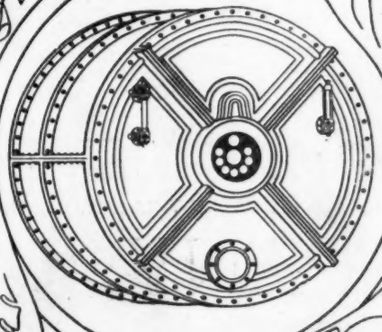

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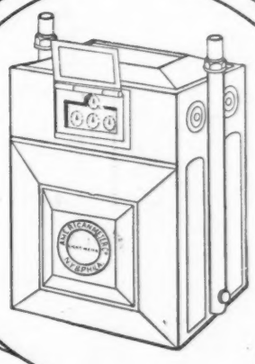
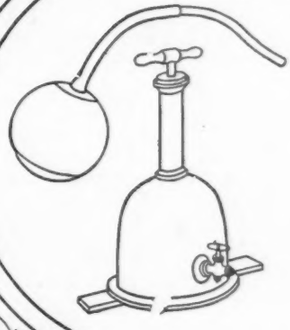
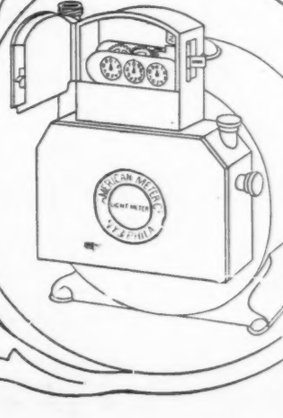






PUBLIC LIGHTING TABLE.

FEBRUARY, 1902.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Sat.	1	5.40 PM	3.20 AM	5.05	6.15
Sun.	2	5.50	4.10	5.05	6.15
Mon.	3	5.50	5.00	5.05	6.15
Tue.	4	5.50	5.40	5.05	6.15
Wed.	5	5.50	6.10	5.10	6.10
Thu.	6	5.50	6.10	5.10	6.10
Fri.	7	5.50	6.10	5.10	6.10
Sat.	8	5.50 NM	6.10	5.10	6.10
Sun.	9	6.00	6.00	5.10	6.10
Mon.	10	6.00	6.00	5.10	6.10
Tue.	11	6.00	6.00	5.10	6.10
Wed.	12	6.00	6.00	5.20	5.55
Thu.	13	10.30	6.00	5.20	5.55
Fri.	14	11.40	6.00	5.20	5.55
Sat.	15	12.40 AM	6.00	5.20	5.55
Sun.	16	1.40	5.50	5.20	5.55
Mon.	17	2.40	5.50	5.20	5.55
Tue.	18	3.30	5.50	5.20	5.55
Wed.	19	4.10	5.50	5.30	5.55
Thu.	20	4.50	5.50	5.30	5.55
Fri.	21	No L.	No L.	5.30	5.55
Sat.	22	No L. FM	No L.	5.30	5.55
Sun.	23	No L.	No L.	5.30	5.55
Mon.	24	6.20 PM	9.20 PM	5.30	5.55
Tue.	25	6.20	10.20	5.30	5.55
Wed.	26	6.20	11.10	5.30	5.45
Thu.	27	6.20	12.10 AM	5.30	5.45
Fri.	28	6.20	1.10	5.30	5.45

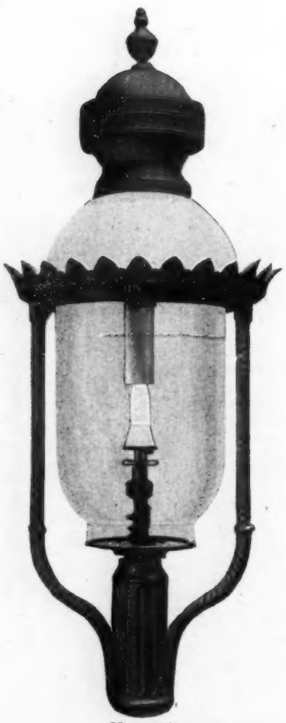
TOTAL HOURS LIGHTING DURING 1902.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	238.30	January	423.20
February	196.20	February	355.25
March	196.20	March	355.35
April	166.40	April	298.50
May	151.40	May	264.50
June	131.10	June	234.25
July	142.40	July	243.45
August	162.00	August	280.25
September	179.00	September	321.15
October	216.30	October	374.30
November	224.10	November	401.40
December	250.00	December	433.45
Total, yr.	2255.00	Total, yr.	3987.45

NEW YORK, 33 Nassau Street. PHILADELPHIA, Broad and Arch Streets. CHICAGO, Foot of Orleans Street. BOSTON, 624 Tremont Building.
CLEVELAND, 809 Cuyahoga Building. ST. LOUIS, 712 Roe Building. SAN FRANCISCO, 712 Polk Street.

WELSBACH STREET LIGHTING COMPANY

.... OF AMERICA ....



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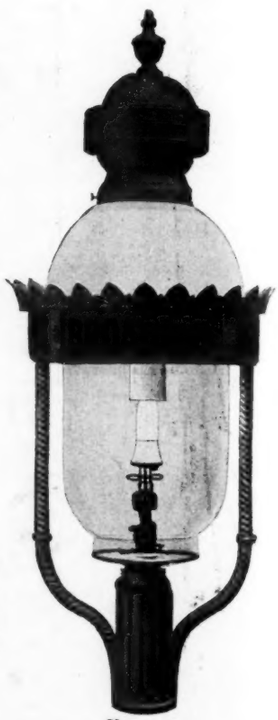
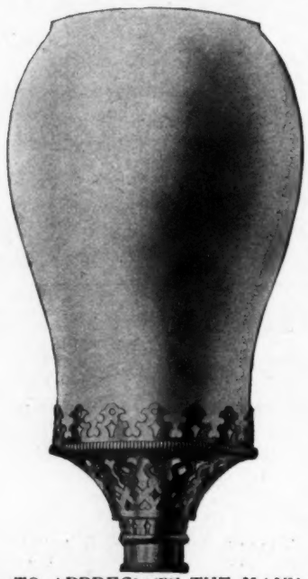


No. 38.

UNIVERSAL WELSBACH BURNER.



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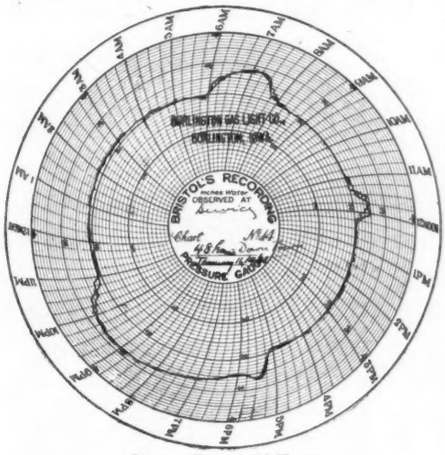

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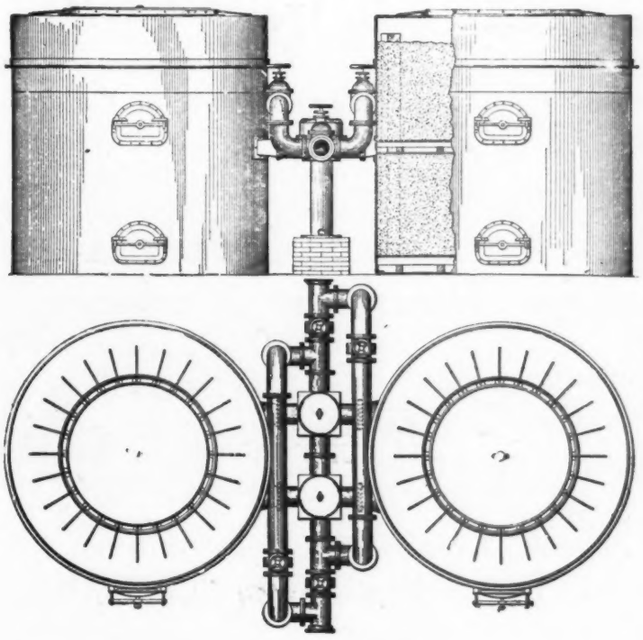

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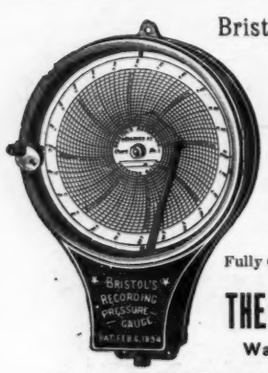

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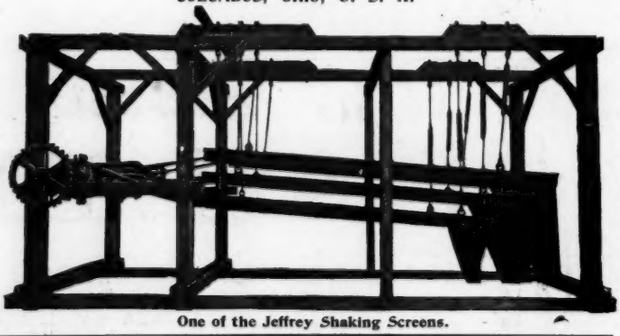
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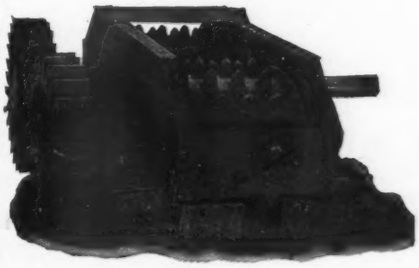

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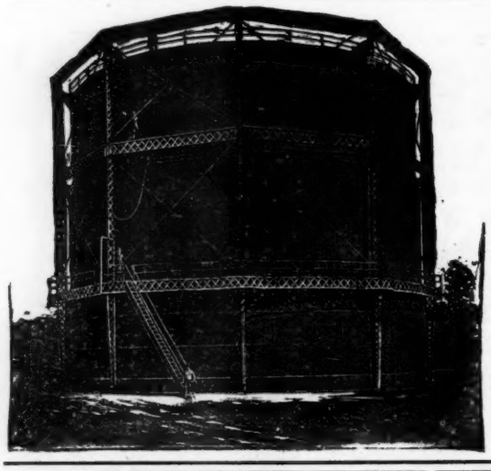

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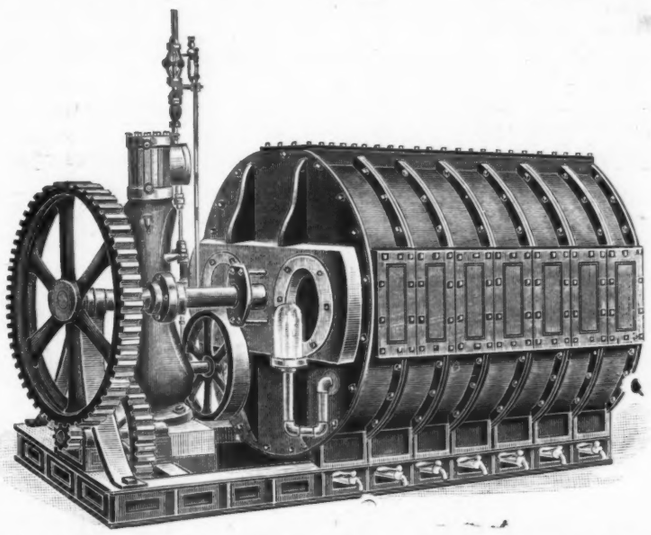

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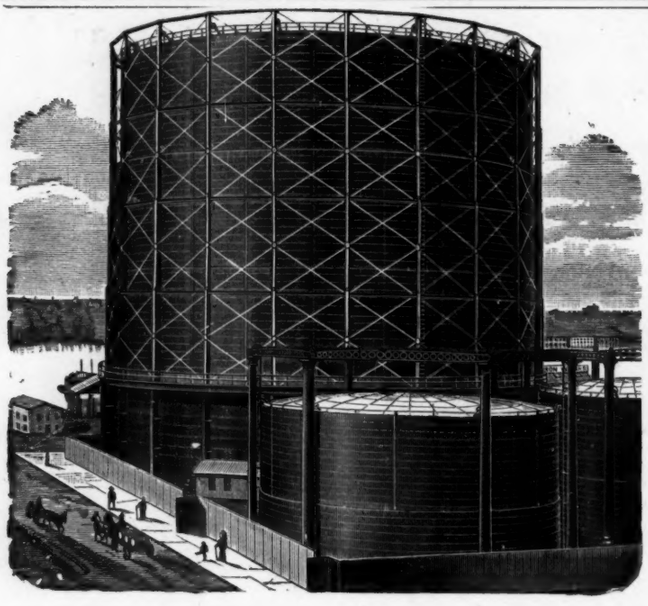

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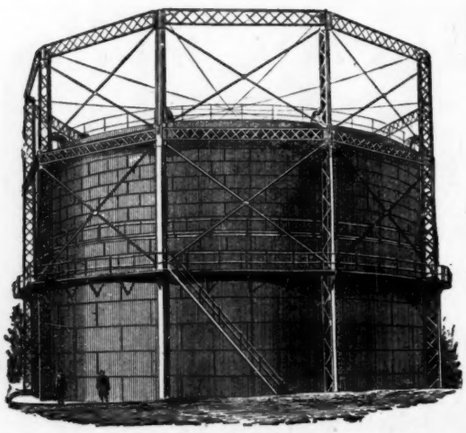

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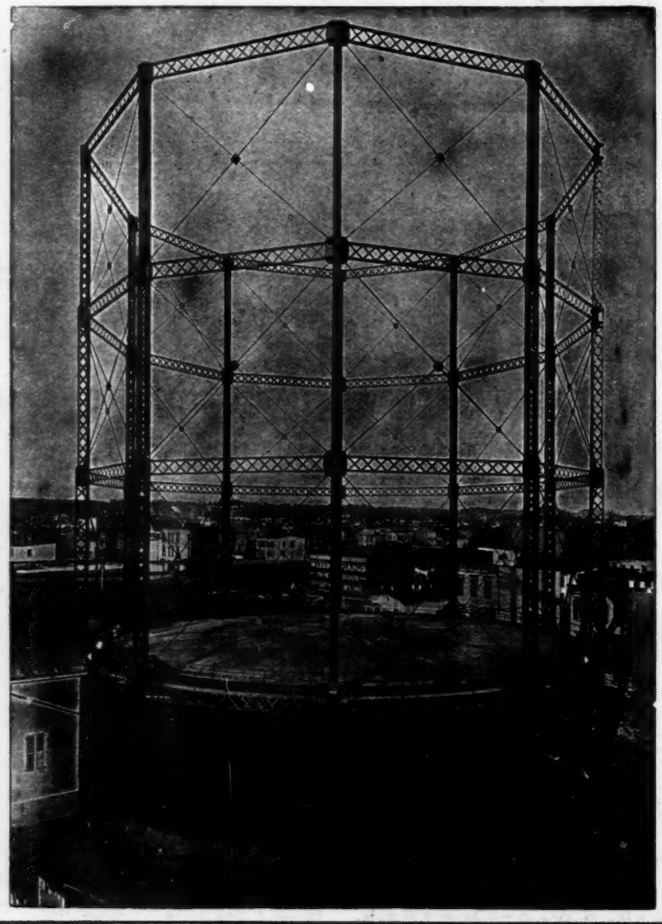

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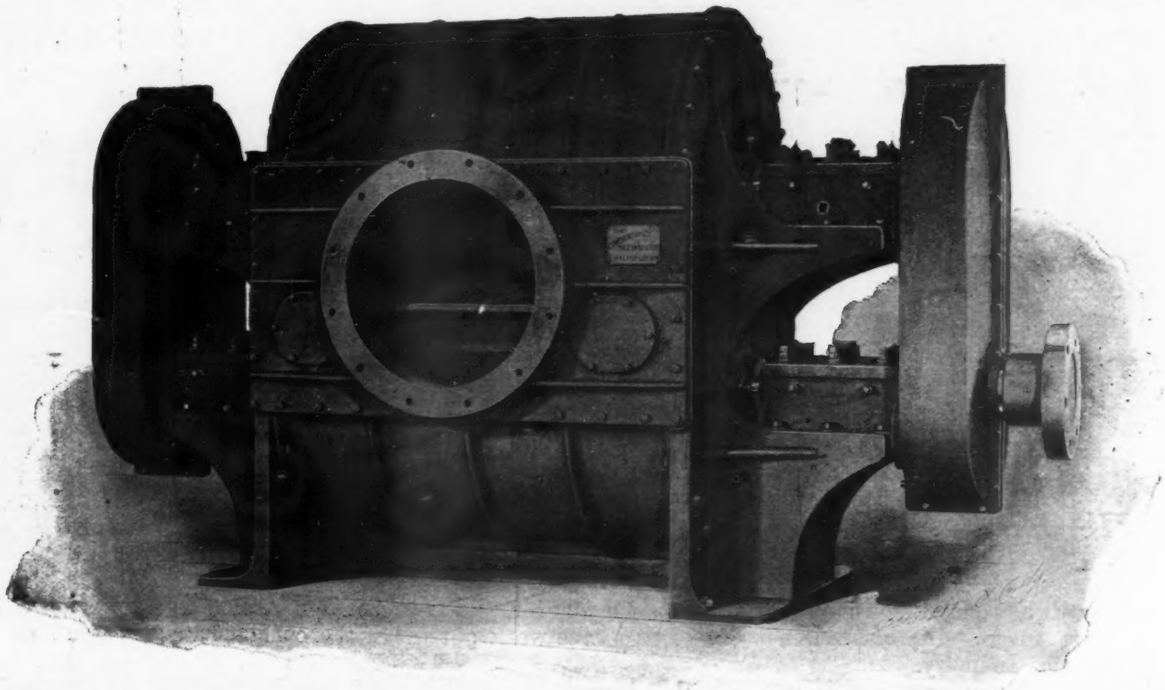

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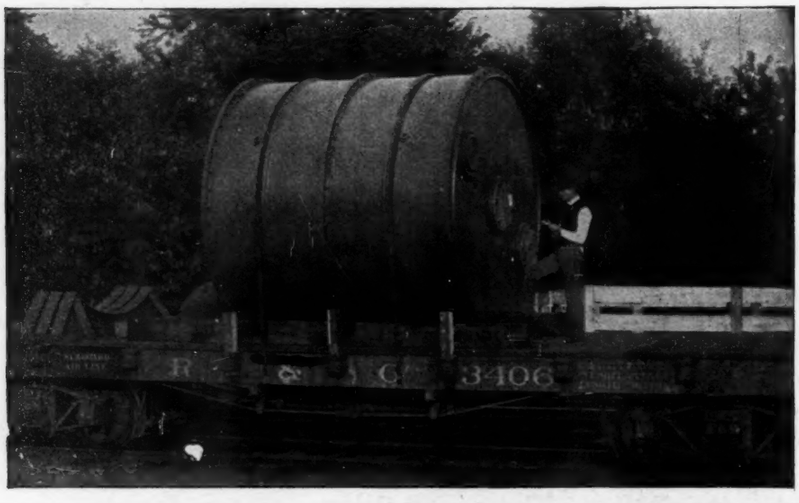

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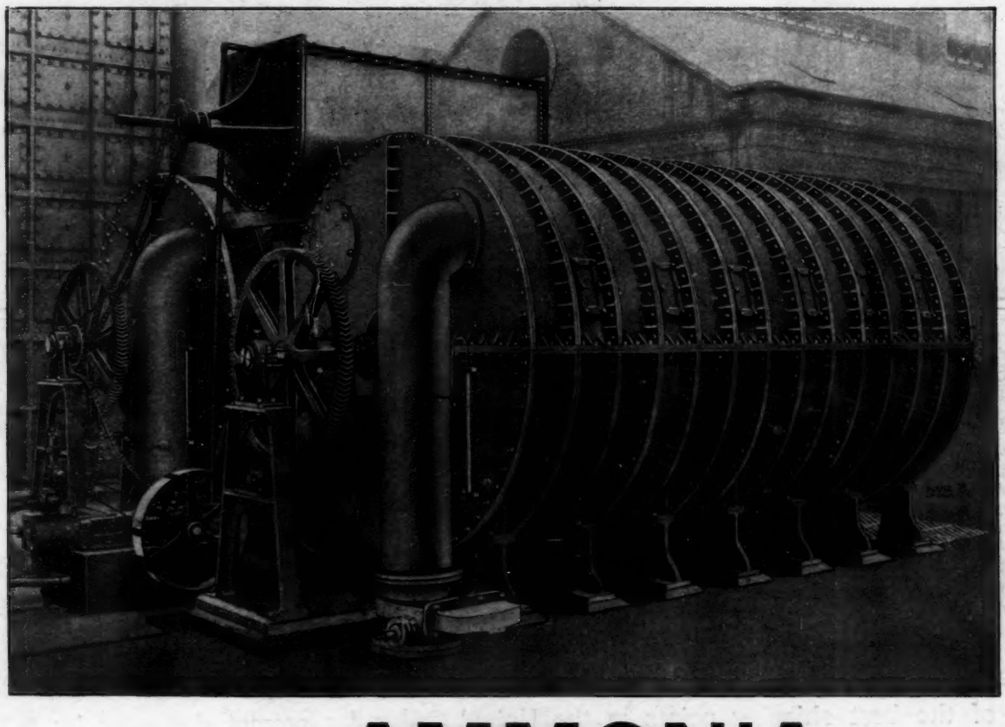

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